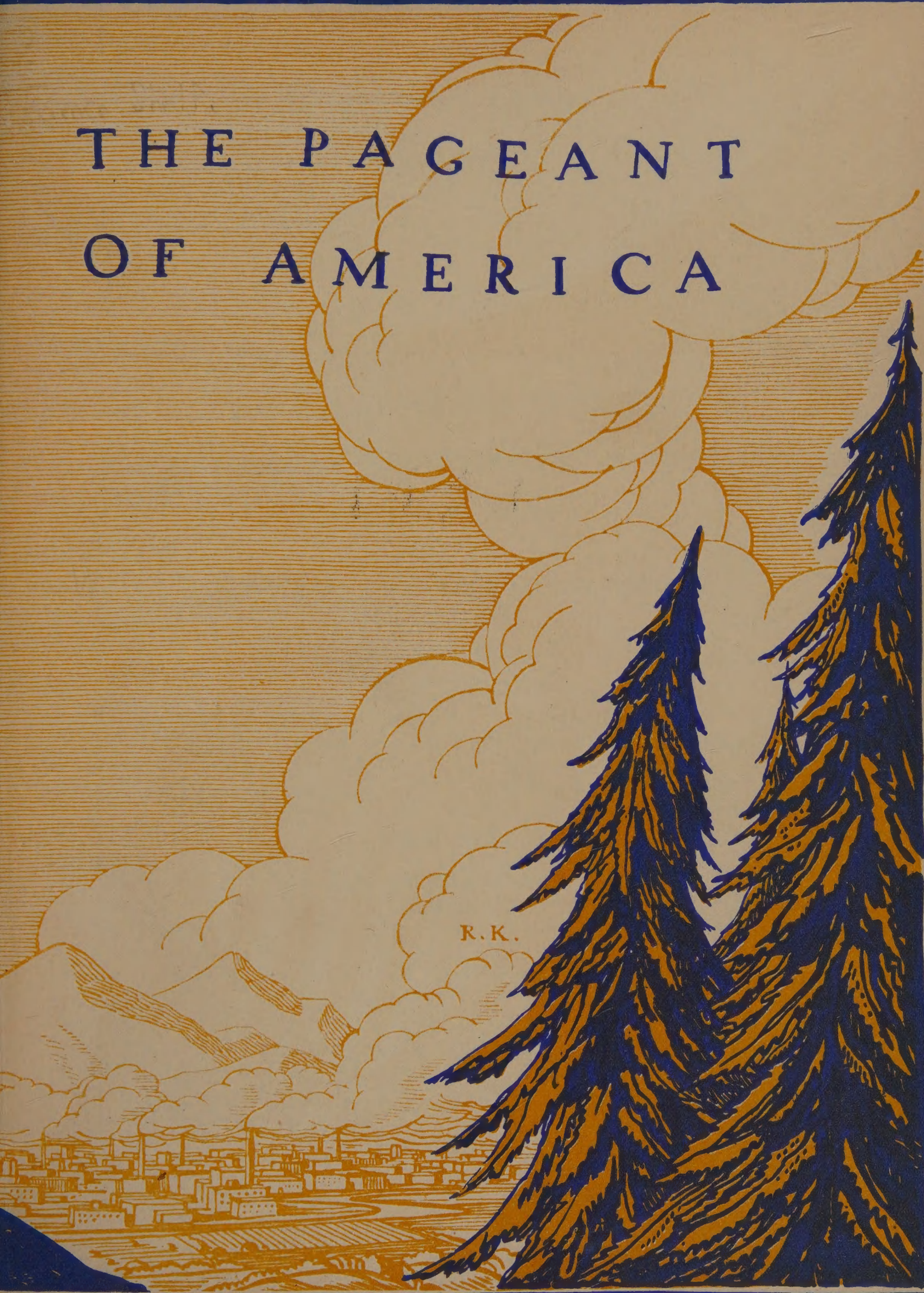
LIBERTY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VOLUME V

THE PAGEANT OF AMERICA

A PICTORIAL HISTORY OF THE UNITED STATES

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From the painting by Gerrit A. Beneker (1882–) in his possession

THE BUILDER

I am the Builder; on my throne
Of iron and wood and steel and stone,
I stand, the Builder, but not alone: —
In God's own image, from God's own plan
From common clay, He built Me, Man,
From common clay, He raised the ban
That I might live — but not alone.

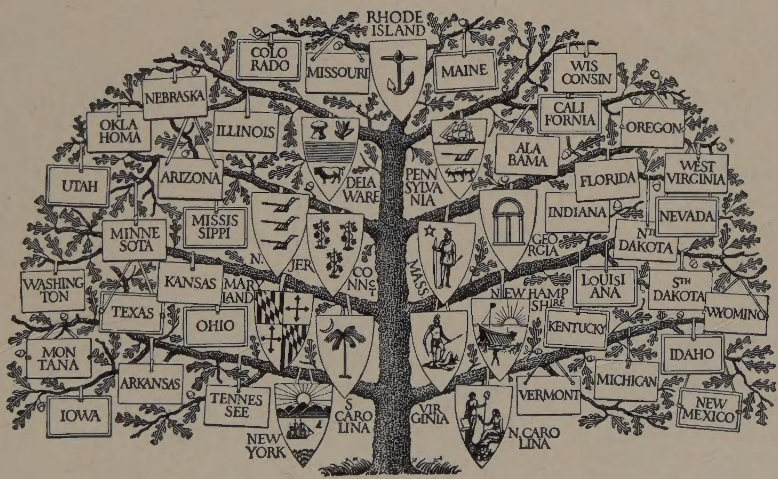
From God's own earth I scoop the ore,
The coal I mine, the rock I bore,
The Lightning's flash from the air I store: —
This clay fuse I — with fire to mock
The Ancient Gods; their temples rock,
Crash back to earth, tongues interlock
To build no Babel as of yore.

Where once a hillock was but small,
I build the city towering tall,
The peasant's hut, the marble hall: —
With men from many a foreign strand,
I build with heart and soul and hand
America — the Promised Land!
Build all for each, build each for all.

THE EPIC OF INDUSTRY

BY

MALCOLM KEIR



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THE EPIC OF INDUSTRY

IN the seventeenth century on the wooded bank of the James River a busy group of Englishmen unloaded from three small ships a quantity of axes and adzes, hoes and firearms, including some small cannon. Soon after a redskin, trained to hunt with bow and arrow, bore to the Indian villages up the river news of the coming of the whites. The age of iron had come suddenly into contact with the age of stone. The two cultures were widely different. The Indian used wood for his bow, the shafts of his spears and arrows, and for the framework of his lodge, which he covered with bark. Of both logs and bark he made canoes. He wove reeds into baskets and fiber into cloth. He made shapely vessels of clay. The skins of animals he turned into clothing and blankets, and of a shoulder blade he sometimes made a hoe. He could hammer copper into ornaments. Though his culture was primitive, he was a craftsman with a craft knowledge which had come down from antiquity, and the greatest of his arts was his stonework. The finely chipped arrow point of chert (rock-flint), the beveled and polished knife, or the decorated stone pipe, inevitably arouse admiration for the skill, the sense of proportion, and the feeling for beauty of the artisan who shaped it. Fire and human energy were practically the only natural forces that he utilized.

The Europeans who now settled along the Atlantic shore had, about two thousand years before, in Britain, outgrown the cultural stage in which they found the Indians. They too used the energy of fire and the human body, but they had also domestic animals. They spread sails to the wind and harnessed the power of the waterfall. The use of the magnetized compass had become common among them. They had learned the advantage of the lever and the value of the wheel. Like the Indians they used wood, but they built it into houses of timber and ships that crossed the ocean. They made bricks as well as pottery of clay. Their stone was not chipped into arrow points, but was built into castles and cathedrals. They had discovered where iron ore lay exposed on rough hillsides or hidden in swampy bogs, and had learned to shape the crude product of nature to their ends. This knowledge represented one of their most important adjustments to their natural environment. Iron sickles cut their grain and their plows had iron points. Iron tools aided their stone masons. Iron cannon belched fire and smoke as they hurled iron projectiles at the enemy. The blacksmith, an ironworker, was a person of consequence; only a few centuries before he had been deemed a wizard. But seventeenth-century European life, like that of the Indian, was still in the age of the handicrafts.

The English manufacturers were the goldsmiths, the silversmiths, the cobblers, the tanners, the cabinetmakers, and a host of other artisans. In the shops of these workers the raw products of nature were turned into articles which formed the material basis of Western civilization. The variety and profusion of the things they made measured the advance of the whites over the culture of the Indians. Their production implied a complex social organization. The forest-dwelling redskins had developed a simple division of labor. The medicine man had his peculiar function, and sometimes the arrow maker was kept steadily at his special task. But otherwise the men of the village were by turns hunters, fishermen, warriors, or artisans as occasion demanded. In the European community specialization of function was marked. The tailor or the blacksmith was able to devote himself entirely to his trade with the consequent economic gain that followed the development of skill and speed. The English town from which came so many of the

first pioneers in America was to a considerable extent a group of specialists. America had the fortune to be settled in the centuries when the handicrafts of Europe reached their highest development. This craft knowledge and manual skill went overseas with the people who built their villages on the banks of the James, the Delaware, or the Cooper, and this heritage of craft lore was admirably fitted to serve the needs of a thinly held European frontier separated from the homeland by three thousand miles of ocean.

But the English villages in America did not at once assume the complex character of the Old-World towns. Life on the edge of the forest meant a hand-to-hand struggle for existence by a small and isolated group in which division of labor all but disappeared. Every family supplied its wants as best it could. Of necessity the earliest settlers, no matter what their former occupations, turned to agriculture as the only source of a dependable and adequate food supply. Yet the householder must be more than a farmer. With the aid of his neighbors he built his house and provided it with furniture. He contrived many of his most essential tools and stood ready at all times to repair a break. He learned much from the Indian to aid him in the food quest, but otherwise the red-skinned artisans had little to teach him. His craft knowledge, as indispensable as his husbandry, came wholly from Europe, and with this the English immigrants were able in less than a century to gain a permanent foothold on that long coast from New England to Carolina.

For nearly two centuries the handicrafts served the needs of life in America. As the seventeenth century passed into the eighteenth, the primitive character of the first communities disappeared. The miller, the carpenter, the cobbler, the tailor, and the doctor began to provide the division of labor that was characteristic of European towns. The eighteenth-century traveler in Boston or Philadelphia would, again and again, in the houses, the shops, and the signs of the artisans be reminded of contemporary England. Life in the New World had passed the stage of the rough struggle with nature, and the craftsman had assumed an importance comparable to that in the Old World. Westward expansion, which by the middle of the eighteenth century had reached the Appalachian mountains, presented new problems. Distances in the new country were greater than in England, and the age of handicrafts offered nothing better than the small sailing ship and the coach that traveled on unimproved roads. Even between the seaboard colonies communication was difficult and infrequent, and the interior existed in almost complete isolation. When the colonies united to throw off the political yoke of Britain there were many thoughtful Americans who believed that success in arms must inevitably be followed by disintegration of the new state. Yet, by a curious turn of fate, the very years of the American War of Independence saw in the enemy country the beginnings of another revolution that was one day to play a determining part in keeping the new nation intact and in making possible its swift expansion across the continent.

The Industrial Revolution in England, in the last third of the eighteenth century, marks a turning point in the history of Western civilization. Yet, in part, it was but the surface manifestation of another development of even greater significance. From the earliest days of the evolution of the race men had adjusted themselves to their natural environment by the method of trial and error. This time-honored method had produced in Europe the cultures of Greece and Rome, and in America the civilization of the Mayas. In Europe, as the Middle Ages ended, the conviction of some ancient Greek thinkers that the earth, and the universe of which it is a part, is governed by law began to develop. Slowly the scientific method of experimentation and the open-minded gathering of many facts came into being in the investigation of nature. This was not a spectacular event, but the work of many men in many places and the result of efforts continued through many years. It was an achievement almost, if not quite, as important as the taming of fire in the primitive days of the race. Fire made possible a vast new set of human adjustments to the natural environment. The scientific method opened the way to an orderly

and intelligent investigation of nature and to an almost unlimited utilization of natural products and forces.

In the latter years of the eighteenth century a group of English inventors applied the principles of mechanics to the building of labor-saving machines. They also made practicable the use of the energy that resides in steam. The new machines and the new power were but one phase of the Industrial Revolution; the other was the gathering together under a single roof of the devices and the laborers to run them. The factory system as a form of economic organization was created. When in America Thomas Jefferson was first elected President, the Industrial Revolution was profoundly modifying English life. The old handicrafts were steadily giving way to the factory with its machines. The nation, not without much economic distress, was shifting to a new industrial foundation. But in America, when Jefferson was inaugurated, the handicrafts were yet supreme; only an occasional factory had appeared in the communities of the United States.

The reasons why the Americans were slow in utilizing the machines and the organization created by the Industrial Revolution are not far to seek. The machines were expensive and the factory required a large investment. The people of the United States had little fluid capital, their resources having been used up in establishing and equipping farms or in building and maintaining ships at sea. Moreover, there was little of the necessary labor supply in communities from which men were constantly going west to clear the forest and secure independent holdings. Jealous English owners, also, strove to keep for themselves the benefits of the great discoveries and inventions. No machines or even drawings of a machine were knowingly permitted to leave the land. A decade of the nineteenth century passed before the factory system made any appreciable impress upon American communities. It became firmly established in the United States only because of artificial conditions created by the Napoleonic wars and the War of 1812. From 1807 to 1815 the American merchant marine was buffeted by adverse conditions, and the importation of manufactured goods from England was difficult or impossible. So factories sprang up and, for the time being, capital turned from sea to land enterprises.

Visitors in southern New England, New York and New Jersey, in the days following the War of 1812 were struck by the changes they found. "In the three eastern districts of Connecticut," wrote Tench Coxe, "the traveler's eye is charmed with the view of delightful villages, suddenly rising as it were by magic, along the banks of some meandering rivulet; flourishing by the influence and fostered by the protecting arm of manufactures." Had the traveler paused in one of these hamlets and gone down to the textile factory which lay below the stone dam that had been thrown across the stream, he would have found the doors open well before sunup in the short days of fall and winter and a troop of children thronging in to tend the machines until sunset. Factory wages had drawn them, and with them often their mothers and older sisters, away from the stony farms on the hills about the valley. Their fathers still cultivated the fields or found work in the village.

The factory towns of contemporary England afforded considerable contrast to most of those in America. There were places in the United States where factories were filled with employees of a low type, and where conditions developed comparable to those in towns like Birmingham, where so many of the laborers were recruited from a hopeless pauper rabble. But, in general, the laborers in the early American factories came from substantial farming folk. Rarely, if ever, would the traveler in the United States come upon filthy dormitories into which children were crowded without regard to sex to grow up in wretchedness and vice. Child labor was a commonplace in America as in England. Shortage of labor supply made it inevitable in industries like the textiles. Moreover, industrialism was new, and Americans had not yet come to realize the national loss which results from setting their children to work in factories at an early age. On the whole,

and according to the standards of the times, the people of the United States could be proud of the factories which sprang up in the land where the merchant trader had long been the dominant economic figure.

Pennsylvania, as well as New England, felt the stir of the new life. In the eastern valleys and in the country about Pittsburgh, where iron ore was found in limestone strata, stone forges were built along the hillsides and in the valley bottoms. In the surrounding forests charcoal burners were pressed to supply the fuel which reduced the ore to "pigs." The product which flowed from the forges was further refined and wrought into the tools and machines, the stoves, the anchors, the decorative iron fences and gates, and the host of other metal objects that the growing life of America required. As the frontier, pushing westward across the great central plain, increased the demand for guns and for agricultural implements, the stone forges grew larger, and their far-sighted owners bought up vast tracts of forest to insure their future supply of charcoal. The traveler of to-day may find the ruins of these old, stone-throated monsters, cold now for many decades, standing moss-covered and deserted in the midst of trees and undergrowth. And in New England, were he to walk up many of the small streams where, a century ago, the children came each morning to the little factories, he would find but a succession of broken dams, an occasional crumbling wall of brick, and perhaps the skeleton of an ancient water wheel half imbedded in the gravel of the creek bottom. The new era which replaced the old came into full being in the years which followed the war between the North and South.

The history of the three decades following the Civil War is the story of the most remarkable economic and social transformation in the history of the people of the United States. Within the area of the United States lie natural resources greater by far than those of any other nation. Of coal, the chief producer of energy in modern times, the American republic has more than half the world's reserves. In the Lake Superior and southern Appalachian fields the United States has some of the chief iron deposits of the earth's crust. Only in Great Britain, the Lorraine-Ruhr region, and the United States, are iron, coal, and a large iron and steel-consuming market situated close together. These three have become the iron centers of the world, with the United States producing at the end of the first quarter of the twentieth century forty per cent of the world's iron output. America is rich in copper, silver, gold, and many lesser minerals. Vast petroleum pools lie hidden beneath the surface soil. There are many streams whose energy may be turned to productive uses. For more than two centuries this tremendous wealth had remained almost untouched. At once a combination of circumstances wrought a profound change.

The most important of these was the growth of scientific knowledge and its application to the practical affairs of life. By 1850 chemistry, physics, geology, and biology were well beyond their uncertain beginnings. The larger part of the scientific research up to that time had been done in Europe but most of the knowledge thus gained became general property. Geologists explored with the utmost care the area of the United States to determine the location and the magnitude of the natural resources of the nation. Their work made clear to Americans the real character of the environment in which they lived. Much had already been learned from the unscientific prospectors who, following the California gold rush, had threaded the gorges and clambered through the passes of the western mountains in search of yellow nuggets. Some had found gold, and in the decades of the 'fifties and 'sixties miners had rushed to strike after strike. The flow of gold from new sources increased the nation's fluid capital, and stimulated business and made easier the application of scientific knowledge to industry.

During the first half of the nineteenth century Americans, while not abreast of Europeans in scientific research, had earned a reputation for "Yankee inventiveness." They had given the world vulcanized rubber, the reaper, the sewing machine, and the telegraph,

together with many lesser devices. Moreover they had vigorously attacked the problem of transportation. The great distances of America had exercised a profound influence over its industrial advance. In the early decades of the nineteenth century, when transportation facilities were limited to rivers, the sea, turnpikes and an occasional canal, the factory was limited by the area from which it could draw its raw products and in which it could sell its manufactured goods. The canal had offered a partial solution. But before its possibilities could be fully determined Americans had turned to experimenting with railroads. In the decade before the Civil War the railroad became definitely established as the most important solution of the American problem of distance. Following the war came a period of railroad building without parallel in world history. Within fifteen years after the surrender at Appomattox, no less than four railways bound the Atlantic to the Pacific, and from 1880 to 1890 the railroad mileage of the United States jumped from more than ninety-three thousand to well above one hundred and sixty-three thousand miles. The United States was welded into an economic unit without customs barriers from ocean to ocean. No longer was the manufacturer held within the confines of a narrow section for his raw materials, and he could sell in a market that stretched from Florida to Oregon. In this great area lived a rapidly growing population with common tastes and a common standard of living. The development of science and one of its products, the railway, were two of the factors which made possible the utilization of America's vast natural wealth. The third was the contribution of the practical man of affairs.

Inevitably the last third of the nineteenth century was marked by a fierce and often ruthless struggle for power. Strong men appeared who towered above their fellows. They owned factories or railroads. They were the dukes of the new era and, as was the case with their feudal predecessors, the welfare of many persons rested in their hands. Frequently they fought one another as the barons had done of old. Then competition began to disappear as men learned the power and profits that flow from combination. The greatest of the new leaders combined men and capital into corporations which were developed to gigantic proportions. American life was wrenched into a new form as a national division of labor was perfected. At the close of the Civil War the United States was far behind Great Britain in industrial importance. In three decades, the span of a single generation, America led the world in the value of its manufactured products.

By the time the twentieth century opened, industrialism had become a factor of the first importance in American life. The passing of the frontier and the completion of the greater part of the national network of railroads freed capital for industrial development, and in America this capital was gathered into the greatest financial combinations the world had known. Large-scale production, and the bringing of a succession of manufacturing steps under a single control, resulted in an efficiency which made possible American competition with foreign producers who paid lower wages to their laborers. Scientific investigation was accelerated as laboratories became a part of the equipment of many industrial establishments. Nature was ransacked in a systematic manner for every element and every source of energy that might be turned to the amelioration of human life. In the processes of industry, the iron man steadily replaced the human hand. The automatic machine controlled by the giant corporation is the triumph of the age of industry. But all too frequently it reduces the worker to a mere automaton who spends the years of his life feeding a senseless monster.

Labor has prospered with industry, yet the wage earner has had many a difficult problem to solve. The growth of manufacturing put vast economic power into the hands of the successful few. Many of the iron dukes were predatory. The employee fought at times for better working conditions and for wages which measured his standard of living. For two centuries and a half most Americans had owned a farm or a business; a

relatively small part of the population had worked for hire. Industrialism brought to America a growing group of men and women whose sole dependence was a job. And a job was not like a piece of land or a stock of goods in a store; it might vanish when times grew hard and no one know why it had gone. To protect himself against the vicissitudes of his economic position, the wage earner sought to organize. In the 'seventies and 'eighties he developed the spectacular Knights of Labor which, after claiming a membership of a million, fell suddenly into collapse. Other organizations have followed and have gained power far beyond that of the Knights in the heyday of their greatness. Yet, in America, labor organizations lag in their growth behind those of England. Perhaps one of the reasons may be found in the character of the American wage-earning group.

The rapid exploitation of the natural resources within the United States brought about one of the world's important population movements. Millions of Europeans crossed the ocean to share in the opportunities which America lavishly offered. They built railroads, dug mines, and tended machines in the clattering factories. They brought with them prejudices and inherited national hatreds. Their first problem was to learn the ways of a new nation and to adjust themselves to a new environment. As a group, this polyglot mass did not possess common ideals, and the workers that passed in through the factory gate as the whistle blew spoke a multitude of languages. The organization of such a group presented at times insuperable difficulties. It has never been fully accomplished. Again and again the natural leaders of the wage earners have risen out of the group to become managers. Opportunity has not failed genuine ability. But organization has come, and has aided in improving the lot of the laborer. Coöperation also between employer and employee has increased as the chaotic early years of industrialism have passed, and as the customs and ideals of the new industrial civilization have taken shape. Meanwhile the United States, passing the middle point of the second century of its national history, has become the industrial colossus of the world.

The position of America rests upon its natural resources, and upon the knowledge, energy, and capacity for organization of its people. Industrial expansion has burst the national boundaries. The people of the United States have interests and commitments over the world. They cannot, if they would, refuse to think in terms of world relationships. The past history of America has been the story of the development of economic strength surpassing any in the world. The history of the future must be the chronicle of the use of that strength for good or evil on the earth.

RALPH H. GABRIEL

CHAPTER I

THE AGE OF HOMESPUN

SEVENTEENTH-CENTURY America was vastly different from contemporary England. Englishmen crossing the Atlantic to this distant frontier were plunged into a wilderness to face a rough and dangerous life, and to encounter experiences that were strange and for which the settlers had no training. Seventeenth-century America was little more than a succession of isolated settlements on a coast that stretched from Maine to Carolina. In places, notably New England, villages had appeared in the interior at some distance from the shore. In the Hudson valley a few settlements had been made as far north as the present Albany. From north to south in these embryo colonies life tended to revert closely to a mere primitive struggle for existence. The home group, the man, his wife and children, was thrown upon its own resources. The age of homespun was the inevitable result. From first to last it remained a characteristic of the American frontier. For a generation after the War of Independence the nation itself continued mostly in the age of homespun.

In the colonial era industry was hindered by the overwhelming preëminence of agriculture, the shortage of labor, the lack of fluid capital, the absence of markets for both raw materials and finished products, and the prohibitive costs of transportation. In addition to these natural limitations, the British colonial policy restricted any activity that threatened competition with the workmen of the mother country. Nearly all manufacturing, quarrying, and mining, consequently, were confined to the homestead or to a limited locality.

The colonial period measures more than a century and a half in time. By the first quarter of the eighteenth century colonial communities from New England to the Carolinas had become firmly established and fairly well adjusted to the peculiarities of their particular situations. Yet to the outbreak of the War of Independence the industrial development in America was largely limited to agriculture. Some men in the northern colonies fished for a living. As the years passed, the merchant marine built and manned by the colonists increased in size and importance. The carrying trade proved profitable and commerce grew. The need of ships for the sailors and boats for the fishermen called shipyards into being. Lumbermen furnished naval stores — pitch, masts, resin, tar. But in spite of these developments most of the colonists were dependent upon the soil.

Except among the occasional rich planters of the southern colonies or the large landholders of the Hudson valley, most farmers had little money with which to buy manufactured goods. The larger part of the things they needed they made for themselves. In a new country which they were developing, their standard of living was necessarily adjusted to primitive or semi-primitive conditions. The farmers as a group did not offer an attractive market to the enterprising manufacturer. Moreover, those planters or merchants who could afford to buy luxurious furniture or clothing tended to make their purchases in a foreign market. Merchant traders were constantly dealing in London, and Virginia and Carolina planters were selling their products in the English market. Naturally such folk bought the things they needed abroad. The development of manufacturing in America had to await the further growth of its economic life. Steadily throughout the eighteenth century this growth went on.

1 From the reconstruction in the Chronicles of America motion picture *Jamestown*

A PIONEER HOME, JAMESTOWN, VIRGINIA

The seventeenth century was a time of colonial beginnings. Shiploads of pioneers crossed the Atlantic from Europe to found settlements in the New World. Their first need was shelter against cold and storms. In the earliest English colonies the first habitations were rough tents or dugouts sunk in a hillside. Later came the house made from the materials of the forest. Building a house was a communal enterprise, since there was little or no surplus labor in the settlements struggling for a foothold in the wilderness.

2 A Pilgrim Home, built in 1653, from a photograph by the Halliday Historic Photograph Co., Boston

3 Colonial Carpenter Tools, in the collection of the Pocumtuck Valley Memorial Association, Deerfield, Mass.

BUILDING THE HOME

In the most primitive settlements logs were used whole, care being exercised to select uniform sizes. Then the logs were roughly hewn with an ax or adze. Finally, where saws could be obtained, the logs were dressed into beams and boards. When this stage was reached the roughly thatched roof was displaced by shingles. Gradually a typical colonial architecture was evolved. Variations in the type appeared in the different colonies. Not only in the construction of the dwellings but also for innumerable woodworking tasks in and about the household, a small set of carpenter's tools was a necessary part of a pioneer's equipment. Such tools were either brought from Europe or made at home.

FURNISHING THE PIONEER HOME

THE men of the colonial household built their own homes. They shaped the logs or the clapboards. With the help of their neighbors they put up the structure. To a large extent they made their own tools. They built great plows of wood and shod them with iron. They carved the yokes that the ox teams used. They built much of the interior equipment of the home. The long winter season when there was no work to do in the fields was a favorable time to repair or add to the equipment that the household used in its struggle with the wilderness. Until a cabinetmaker established himself in the community each household produced its own furniture. Tables, benches, chairs and stools were devised from logs and slabs, dressed and smoothed and held together with wooden pins. Bedsteads were similarly constructed, and cradles were made from poplar troughs, peeled hickory bark, withes and rushes. The men also manufactured kitchen utensils of wood. In the wooden tubs, buckets and churns the women made and stored their butter, cheese, dye, syrups, sugar, salt, hominy and meal. Sailors from the coast towns of New England or the middle colonies amused themselves on long cruises by carving small bowls and other wooden articles which they presented to their womenfolk.

4 From the reconstruction in the Chronicles of America motion picture *The Frontier Woman*

5 Kitchen of the Hancock-Clarke House, built 1698. © Lexington (Mass.) Historical Society

6 Wooden Cradle, made in 1700, in the collection of the Lexington Historical Society

7 Home-made Dye Tub, in the collection of the Pocumtuck Valley Memorial Association

8 From the restoration in the Essex Institute, Salem, Mass.

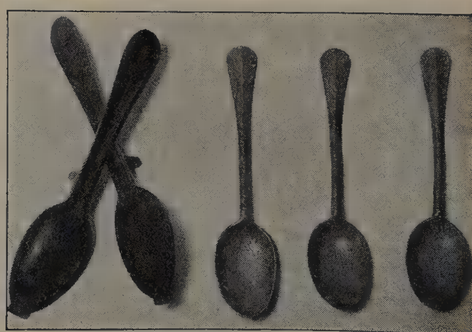
A TYPICAL COLONIAL FIREPLACE, 1750

THE fireplace was the heart of the colonial home. Toward its genial light and warmth the industry and the social life of the household naturally gravitated. Above it apples, vegetables, and cereals were suspended to dry. Around it were hung iron and copper cooking utensils. Such were usually imported, though occasionally a local craftsman possessed the requisite skill to make them. Sometimes even the householder himself, where water-borne commerce brought him bar metal, shaped the commoner utensils and tools.

9 Tableware, in the collection of the Essex Institute

TABLEWARE

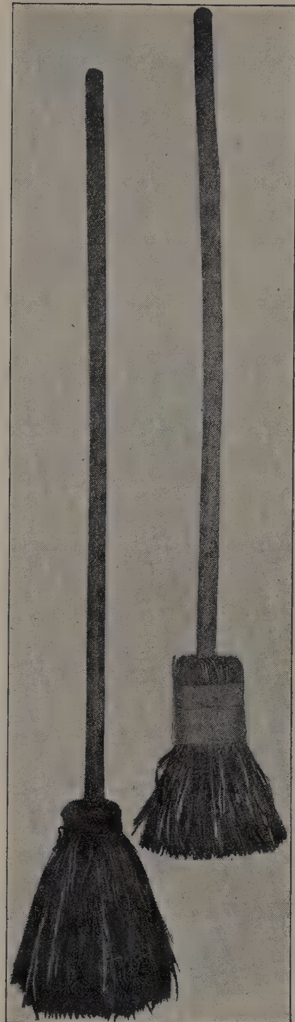
IN later colonial days, except in the back-country, which long continued to use wood, tableware consisted primarily of objects made of pewter, an alloy of tin and lead. Some were crude in form and finish but many were beautiful in design and workmanship. Worn pewter plates were recast into spoons, for which purpose a mold was used. Forks were unknown and not missed, since the food was chiefly soft cereals, vegetables, fruits, or meat cooked into soups, stews or hash. The making of pewter ware was rarely a household industry. Many pieces were produced by colonial artisans, but a great deal, especially the finer pieces, was imported.



10 Pewter Spoons and Spoon Mold, in the collection of the Pocumtuck Valley Memorial Association

THE SPLIT-BIRCH BROOM

AMONG the first necessities of housekeeping is a broom. Borrowing a trick from the Indians, the earliest colonists bound hemlock branches together. Finer brooms were whittled with a jackknife from the trunk of a small birch tree, the splints tied together with hempen twine. Not until 1798, after the colonial period had passed, was broom corn extensively planted. Although within ten years the new product was widely used, the more primitive brooms persisted in the frontier homesteads almost to the middle of the nineteenth century.



11 From the originals in the collection of the Pocumtuck Valley Memorial Association

12 From *The Growth of Industrial Art*, Washington, 1892

CANDLE MAKING IN THE COLONIAL HOME

FROM the Indians the pioneers learned to use knots of fat pitch pine to light their houses. For themselves they discovered it was wiser to burn them near the fireplace, where the smoke and tar driblets proved less troublesome. Although this "candlewood" remained in use to a slight degree until after 1800, colonists generally obtained light from tallow candles.

A characteristic woman's task of the old-time, self-sufficient household was candle making. During the year tallow had been carefully saved. In the fall, when the days were shortening and the men were busy with the flails on the threshing floor, the women made the candles for the winter evenings. Hemp, tow, cotton, or even milkweed were twisted into wicks and tied to the candle rod. The wicks were dipped into a kettle of hot tallow and, one by one, the rods were hung upon a rack to cool. Again and again the dipping was repeated until, at length, the candles attained a sufficient diameter. Candle making was a long task that the housewife was glad to have behind her.

LARGE AND SMALL CANDLE MOLDS

IN the course of time dipping gave place to the pewter or tin candle mold, so arranged as to produce from two to a dozen or more candles at once. Itinerant candle makers carried with them much larger molds. In the molds a wick was let down into each opening and melted tallow poured around it. The new device freed the woman of the household from a hard and tedious task.

13 From the originals in the collection of the Pocumtuck Valley Memorial Association

14 From the originals in the collection of the Essex Institute

COLONIAL CANDLESTICKS AND IGNITING DEVICES

Besides the glow of the fireplace, tallow candles lighted the seventeenth-century settler's house. The crude candlesticks first made by the pioneer gave place to shapely sticks brought from England, or those fashioned by the artisan who established his shop in the village. Types like (1) and (3) have persisted. Type (4), with its two bull's-eye lenses for adding to the brilliancy of the light, is rarely seen. The same is true of (2), which is a combination candlestick and box for flint and steel and tinder. Before the days of matches, sparks were struck into the tinder by a flint-lock (5), or a device like (6), by which a wheel was turned rapidly against a flint by means of a cord. To trim the wick and to prevent smoking after the light was extinguished, a snuffer (7) was used.

THE INTRODUCTION OF THE WHALE–OIL LAMP

Candles were made not only of tallow but of beeswax, bayberry wax and, after the development of whaling, of spermaceti. But the whale fishery introduced a new illuminant, whale oil, which caused an adaptation of the candlestick to the lamp. Of these perhaps the earliest was the "Betty Lamp" (2) whose shape may have been suggested by the candle sconce (1). (3) is a whale-oil lantern and (4) to (7) are oil lamps. The crudity of some of these lamps betokens their home manufacture.

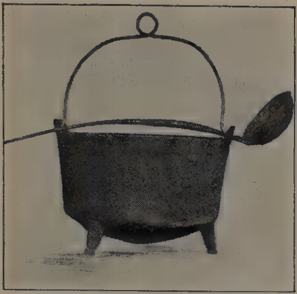
15 From the originals (1–3) in the collection of the Pocumtuck Valley Memorial Association and (4–7) in the collection of the Essex Institute

16 © Keystone View Company

THE MAKING OF BUTTER

One of the earliest lessons in housewifely art taught by the grandmother to the little daughters of the house was the churning of butter. Most of them hated its monotony and heavy labor. Whether they liked the job or not the pioneer women were forced to carry it through as part of their regularly recurring duties. Churns were of two types, the upright sort (No. 16) manipulated with a dasher or paddle, and a barrel (No. 17) with a rotary dasher inside. The hand churn is still common in the country districts of America.

17 Barrel Churn, in the collection of the Hingham (Mass.) Historical Society

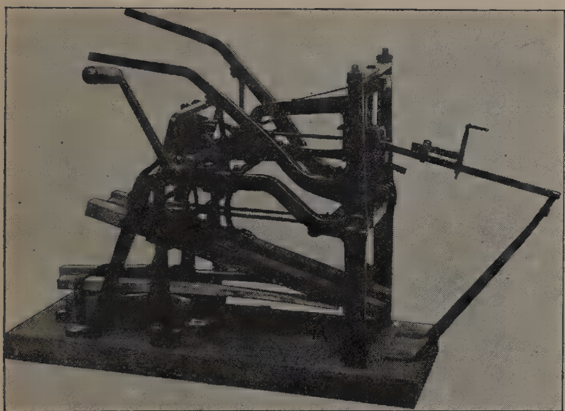


18 Iron Soap Kettle and Leaching Spoon, in the collection of the Hingham Historical Society

THE MAKING OF SOAP

The manufacture of soap was another autumn task of the women. For this purpose two raw materials were necessary; namely, grease and lye. The grease was carefully preserved from household cooking or homestead butchering. Lye was obtained by filling a barrel with wood ashes from the fireplace, through which water was poured. The liquid that leached from the bottom or through the cracks of the barrel contained the necessary mineral matter. To get this lye in proper strength was the chief knack in soap manufacture. The grease and lye were boiled together in pots out of doors, and the result was a soft soap that resembled jelly, which was used for washing purposes about the household. For fine toilet purposes the wax of bayberry made a hard soap that was considered a luxury.

19 From *The Growth of Industrial Art*, Washington, 1892



20 Nathan Read's Nail-slitting Machine, 1798, from the model in the Essex Institute

SLITTING NAILS IN THE HOME

Around the fireside in the evening the eighteenth-century family sometimes eked out its slender income by manufacturing nails and tacks. Bar iron purchased at the store was slit into proper sizes, headed, and pointed. The finished wrought nails were sold or bartered at the store. This industry was eventually driven out of the home by the invention of nail-slitting machines. These contrivances were among the first mechanical inventions of the fertile-minded Yankee. The tack works of modern Taunton, Mass., are lineal descendants of this colonial fireside industry.

THE MANUFACTURE OF TEXTILES

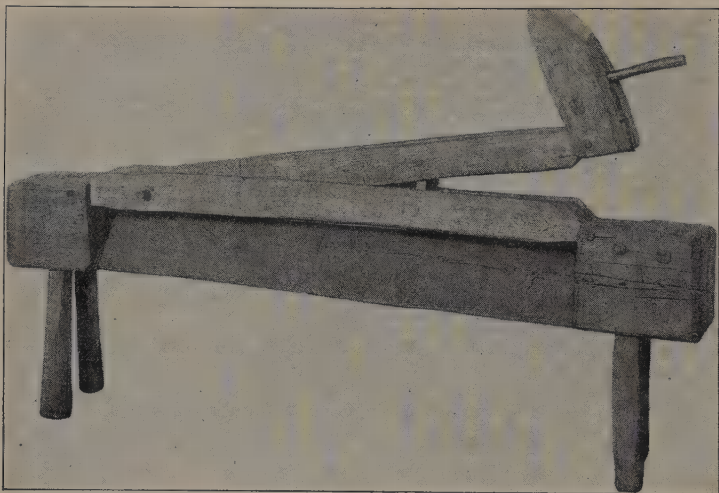
Of all the colonial household arts perhaps the most interesting and familiar was the manufacture of textiles. The usual raw materials were wool or flax obtained from the homestead itself, but hemp, cotton, and even lint from nettles or hair from cattle were sometimes spun and woven into fabrics. The first operation was the preparation of the raw materials for spinning. In the case of wool this consisted merely in washing and straightening the fibers. But flax had to go through several preliminary stages before the fibers could be straightened. The bundles, as they came from the field, were first submerged in water or kept in a cool damp cellar until the hard woody stalk of the plant was rotted. This process must be halted at the exact moment when the outside stalk had decomposed and before rot had attacked the fibers enclosed by the stalk. (1) shows a bundle of rotted flax, (2) a bundle of flax fibers taken from the rotted stalks, and (3) a piece of flax spun into linen yarn. Several processes were necessary before stages (2) and (3) could be reached. North of New York, flax was a kitchen-garden plant, but in the South it had some importance as a field plant.

21 Flax in Various Stages, in the collection of the Pocumtuck Valley Memorial Association

22 From a woodcut by Alexander Anderson (1775–1870)

BRAKING FLAX

To aid in removing the rotted stalk that encloses the flax fibers the bundles were pounded by the machine known as a flax brake (Nos. 22 and 23). This mashed the stalk but, if done carefully, did not injure the fiber.

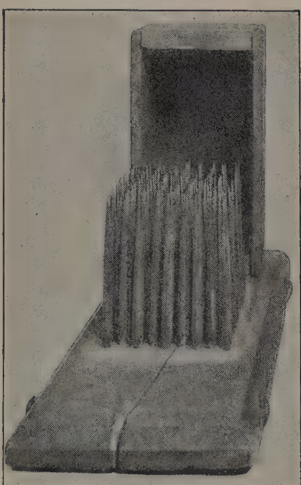


23 Colonial Flax Brake, in the collection of the Worcester (Mass.) Historical Society

24 From the original in the collection of the Pocumtuck Valley Memorial Association

THE SWINGLING BOARD AND SWINGLING KNIFE

The rotted stalk of the flax was also subjected to a further beating by a swingle (No. 24). The ends were trimmed by the swingle knife, shown attached to the upright portion of the implement. The days of preparing the flax were busy ones for both the men and women of the household.

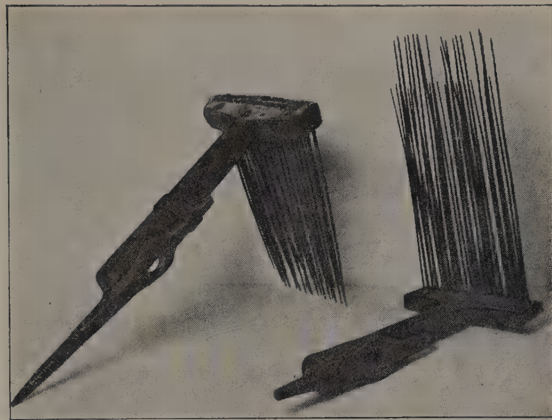


25 From the original in the collection of the Pocumtuck Valley Memorial Association

THE FLAX HATCHEL

When the rotted stalk of flax was entirely removed by braking and swingling, the cleaned fibers were drawn through a hatchel (No. 25) — a comb-like device — which straightened the fibers and laid them all in one direction. The flax fibers were then ready for spinning.

26 Carding Wool by Hand, from a photograph by Rudolf Eickemeyer

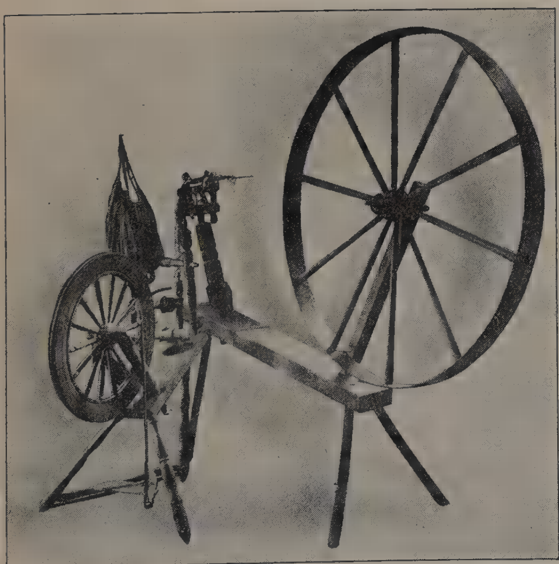


27 Old-time Wool Combs, in the collection of the Pocumtuck Valley Memorial Association

28 Home-made Wool Cards, in the collection of the Pocumtuck Valley Memorial Association

THE PREPARATION OF WOOL

Wool as it comes from the sheep is greasy and full of dirt. In preparing it for spinning it was necessary at the outset to wash it with warm water and soap. When dry it consisted of a tangled mass of fibers which must be straightened and laid parallel with one another. For this latter purpose two tools were used — first a comb (No. 27) for general straightening, and then "cards" (No. 28) for a more careful arrangement of the fibers. The comb was fastened to a wall and the mass of fibers pulled through it. The cards — always a pair — were held in the hands, and small bits of wool put upon one of them. The other card was then drawn across the first, pulling the wool through the teeth of both cards.



29 From the originals in the collection of the Pocumtuck Valley Memorial Association

SPINNING WHEELS FOR FLAX AND WOOL

The combed lint, either wool or flax, was next put upon a distaff and spun by means of a wheel, fliers, and spools, with the deft manipulation of feminine fingers. The wheels for spinning wool were large; flax wheels were small. Sometimes the yarn (thread), after spinning, was dyed with concoctions made from vegetables, flowers, or wood, but often the dyeing process awaited the completion of the cloth. To facilitate the handling of spun yarn it was usually run on to reels and then on to spools.

A FAMILY AT WORK SPINNING AND KNITTING

30 From *The Universal Magazine*, London, August, 1750

After the yarn was spun it could be knitted, woven or felted. Knitting was performed by hand with the familiar bone needles, although use was also made of a special knitting frame. The woman at the left in the illustration is spinning, the one in the center is winding spun yarn on spools, and at the right is a knitting frame for making stockings. Scenes like the one in this British household were common enough in America. In the neighborhood of Philadelphia nearly every house contained a stocking frame, and the region was one of the first in America to give itself over to a single industry. "Germantown stockings" was a phrase as familiar as the modern expression "Pittsburgh iron." In England the income of many a family was largely dependent upon activities like those shown in the picture. In America the main job of the man was generally farming.

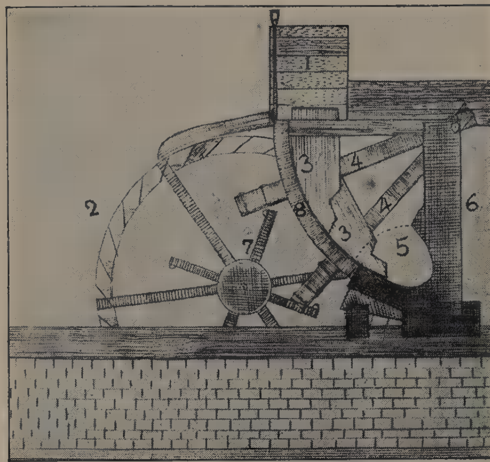
THE LOOM IN THE COLONIAL HOUSEHOLD

A loom for weaving was a necessity in the colonial home. The process of weaving consists in interlocking threads at right angles to one another. The loom held the threads straight and parallel. Alternate threads were one moment raised, and the intervening threads lowered. Through the space between, another thread was passed from the side. It came from a small spool (bobbin) held in the weaver's hand. After the side thread was in place it was pushed by hand against the preceding side thread. This process was repeated and so the cloth was made. Even the crudest loom which could perform all these operations was necessarily a complicated mechanism. Weaving was an art that the colonial woman learned in her girlhood. It was an essential part of her equipment for life.

31 From a photograph posed for the Draper Corporation, Hopedale, Mass.; implements and furnishings in the collection of the Worcester Society of Antiquity

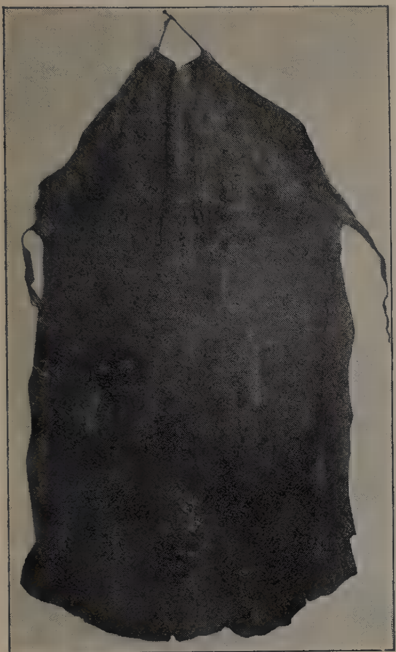
FULLING THE WOVEN CLOTH

Wool cloth when woven was harsh and stiff, and required further handling to soften it. This process, called "fulling," consisted of washing the cloth with warm water and dissolved soap, softening the surface by the inclusion of short fibers, beating it with sticks or mallets, and lifting the nap with teasels. Dyeing might be a part of the procedure also. Finally the cloth was stretched upon a frame (tenter) with hooks (tenterhooks), and left to dry.



32 A Fulling Mill, from Oliver Evans, *The Young Mill-Wright and Miller's Guide*, Philadelphia, 1795

Fulling was among the first of the textile processes to become specialized. The diagram shows an early fulling mill run by water power. The water coming through the spout (1) turned the water wheel (2), the power thus generated operating the two mallets (3) attached to the handles (4). The cloth was put in a loose heap into the hollow or stock (5) of the stock post (6). The mallets, lifted alternately by the tappet arms (7), were guided by the circular guides (8) so as to strike the under part of the heap of cloth, the upper part continually falling over and thereby turning and changing its position under the mallet.



33 Leather Apron, in the collection of the Pocumtuck Valley Memorial Association

THE HOME MANUFACTURE OF LEATHER

Another important product of the household's industry was leather. Hides were obtained from cattle and sheep and from other animals, domestic and wild. Besides its use for foot coverings and harness, leather entered more largely in colonial times than now into the domestic economy of the household. Aprons, shirts, trousers, leggings, thread, petticoats, gloves, caps, bedding, and even drinking vessels might be made of leather.

THE SELF-SUFFICIENT HOME

The home in the early settlements was complete and self-sufficient. The newly cleared land produced the things which the family required. The members of the household turned the raw products to various uses. Life was hard and the standard of living was low. But the condition of sole dependence upon household industry was temporary. It was an inevitable part of gaining a foothold in a new environment. It passed in the seaboard communities as the frontier shifted westward toward the interior of the continent.

34 From the originals in the collection of the Topsfield (Mass.) Historical Society

CHAPTER II

THE COMING OF THE ARTISAN

ALTHOUGH household manufacture is merely a stage in the progress of industrial art, it has been a long continued one in American history because the frontier was for so many years an integral part of our economic organization. Wherever there have been pioneers, at Plymouth, Council Bluffs, Albuquerque or Walla Walla, there household manufacture has of necessity flourished.

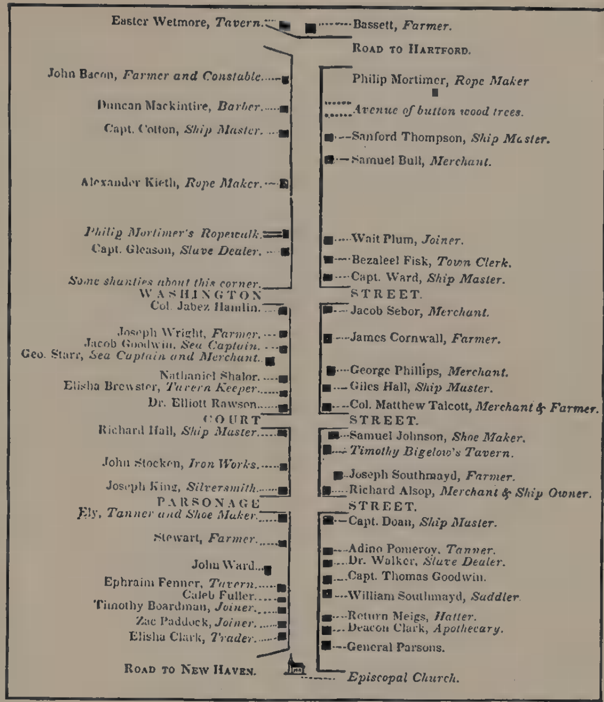
But increased population and improved communication have in nearly every frontier area obliterated more or less completely all forms of household manufacture. The work done by men in the home first yielded to specialists in various crafts who settled in the community. Doctor, merchant, seafaring folk of all kinds, tavern keeper and distiller of rum were among the early specialists for whom a developing village life made room. More slowly the tasks of women have been lightened or changed, first by the specialized artisan, and then by machinery, which is the basis of the modern factory. Usually where water power was available the first local mill to appear was a sawmill. This was followed by a gristmill and fulling mill. It frequently happened that one mill performed several kinds of work at different times, or several such trades might be carried on at once under one roof. Tanneries, distilleries, breweries, bleacheries, dye plants and ropewalks followed close upon the sawmill.

In addition, many hand trades dependent upon skill but not upon power were represented by individuals who walked from one homestead to another practicing the particular craft possessed. The itinerary of these men followed a rough schedule so that the same man appeared at the homesteads season after season. These visits were eagerly awaited by all households, and prepared for in advance. With increasing population such itinerants settled down in the villages and hanging out a shingle cared for such custom as presented itself.

The eighteenth century was the time when the artisan firmly established himself in the English colonies in America. The sea trade and the plantation created a small group who were moderately wealthy. The commercial towns of the coast such as Boston or Philadelphia grew into small cities. Household manufacture was not well adapted to urban life. The artisan became a necessary part of the increasingly complex life of the time. Carpenters, blacksmiths, tailors, shoemakers, hatters, and many more served the growing demands of the communities. The apprentice system of the Old World was transferred to the New. Benjamin Franklin, the printer, became the most distinguished product of this school. One of the most important of the colonial artisans was the hatter. The making of men's hats was one of the first industries to pass out of the stage of household manufacture. English hatters, seeing their colonial market curtailed by an increasing number of hat makers in America, sought to save the situation for themselves by restrictive legislation on the part of the English government. But the restriction was never effectively enforced. In other industries the home government was more successful in the repression of competitive manufacturing activities on the part of the colonials. Yet, in spite of all restrictive measures, the artisans increased in number. Their appearance marked one of the first steps toward the establishment of American economic independence.

ARTISANS AND TRADESMEN IN EIGHTEENTH-CENTURY MIDDLETOWN

THE last decades of the seventeenth century brought the beginnings of specialization and division of labor to the pioneer communities of America. The plan of the main street in Middletown, in the eighteenth century, illustrates what might have been encountered in almost any contemporary North American village. Craftsmen and tradesmen had appeared and set up their shops. Barbers and tavern keepers were the natural outgrowth of the village environment. Some towns had doctors, as well as apothecary shops. Middletown lay on the banks of the Connecticut River and ocean-going ships tied up at its docks. Many shipmasters lived in the community and, since New England sea captains were often engaged in the slave trade from Africa to the West Indies and the southern colonies, Middletown was not without its slave dealers. Eighteenth-century Middletown was one step removed from frontier conditions where every man was a jack-of-all-trades and every family a self-sufficing unit.

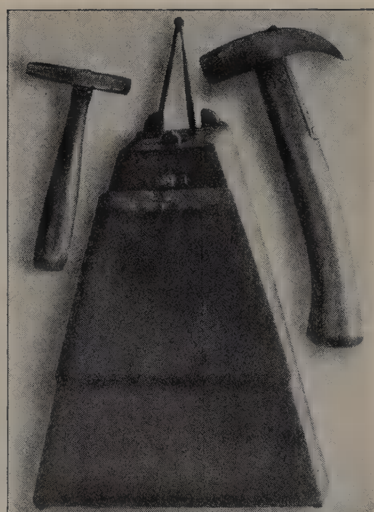


35 From John Warner Barber, *Connecticut Historical Collections,* New Haven, 1836, after a plan by Joseph Barrett

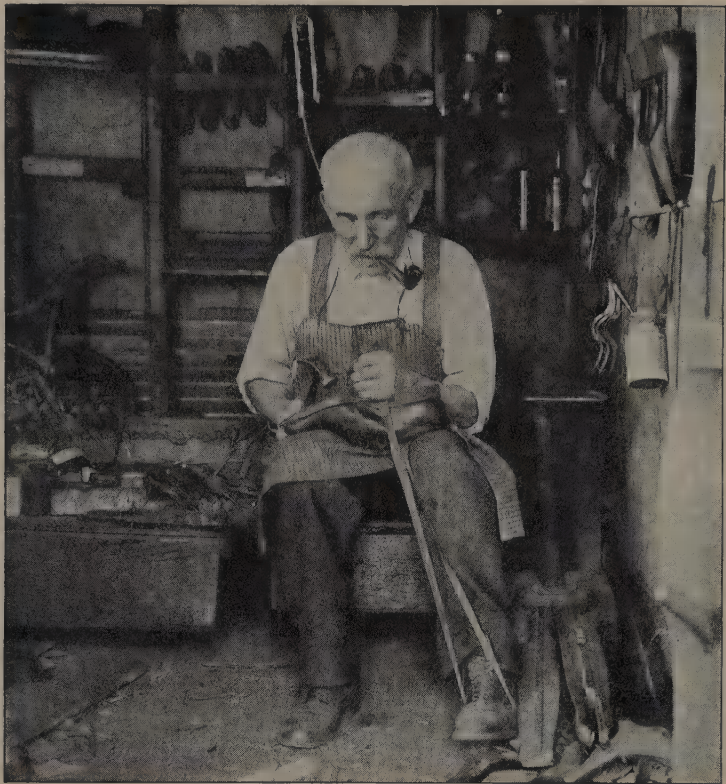
THE TRAVELING SHOEMAKER

THE artisans of colonial America did not wait in their shops for trade to come. Population was small and scattered and the roads were hard to travel. So the early shoemaker journeyed from household to household applying his art to the leather tanned by the householder's family. The simple tool kit offered no great burden and could be carried on the shoulder as the artisan walked from one job to the next. There were probably few homes in which there was not someone who was a fair hand at shaping or repairing footgear, but farm work as well as other occupations was pressing and the services of a specialist were highly welcome.

36 Box of Shoemaker's Tools, in the collection of the Pocumtuck Valley Memorial Association



37 Hammers and Thread Box of a Traveling Shoemaker, in the collection of the Pocumtuck Valley Memorial Association



38 From a photograph, in possession of the author

THE SHOEMAKER OF YESTERDAY

With the growth of settlements or weighed down by his own advancing years, the itinerant shoemaker retired from the road but continued to practice his trade in the village. Housed often in a tiny shed and surrounded by his tools within easy reach, the shoemaker shod the villagers.

In the mid-nineteenth century the development of shoe machinery drove most of these handicraftsmen from their trade, but a few still carry the old tradition into modern times. At the left of this "contemporary ancestor" is a "clamp," his pot of blacking and brush, heel-shaping tools, a "last," and on the floor the wooden forms ("lasts") for making leather boots. Back of him is a lamp used for light and for heating tools. This is one of the two modern contrivances in the place and it dates from the Civil War. The shelves hold various shoe "lasts." In the right corner is one of the first sewing machines devised for shoemaking, the second "modern" device in the shop. At the shoemaker's right is his bench upon which go all his tools. Part of the bench is a seat for the worker. This picture was taken in 1923, but except for the two devices noted it might just as well have been made a century and a half ago.

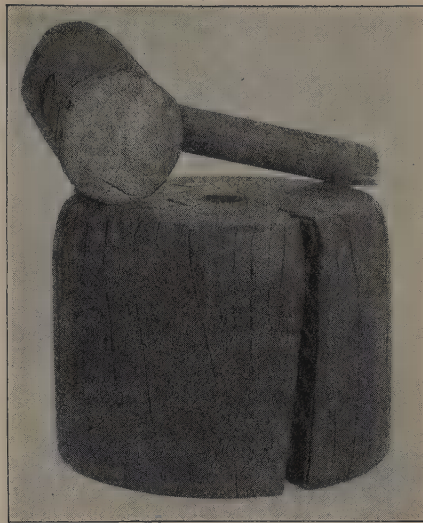
THE TRAVELING TINKER

The ancient tinker himself was so much a jack-of-all-trades that his name has come to stand for makeshift mending or patching. Roving without plan or following a flexible itinerary, the tinker put to rights any domestic utensil made of metal. With his stove, solder, soldering irons, metal scraps and all sorts of odds and ends he put in order many articles that had come to be the despair of the housewife. There was work and welcome for him at nearly every homestead on his way. In the early nineteenth century, after Waterbury, Thomaston, and New Haven had flooded the country with cheap clocks, itinerant repairmen known as clock tinkers joined the fraternity of the highways. These traveling artisans made a contribution to the social life of the folk they visited. They supped and slept with the families they served. While at their work or seated before the fire when it was done they passed on to eager listeners the gossip or the news they had picked up in their wanderings.

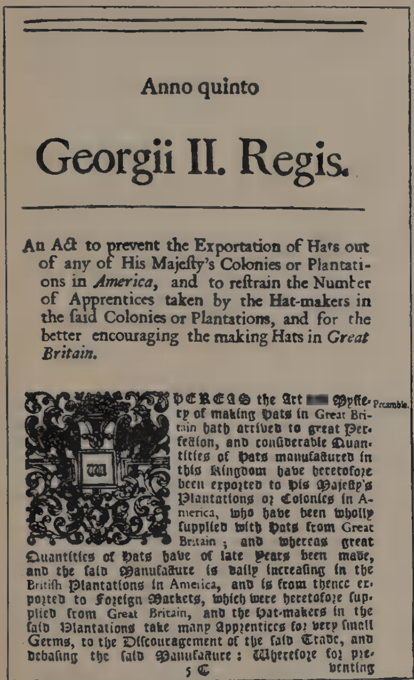
39 From a photograph by Clifton Johnson

HATTER'S BLOCK AND MALLET USED IN 1765

An early craftsman who helped to lighten the household work, but who did not travel from home to home, was the hat maker. The fur of rabbits, beavers, and muskrats being plentiful in America, the demand for hats incessant, and the rudiments of the hat maker's art simple, it was natural that hat making should be one of the first industries to reach considerable proportions before the Revolution.



40 From the collection of the Pocumtuck Valley Memorial Association



Anno quinto

Georgii II. Regis.

An Act to prevent the Exportation of Hats out of any of His Majeſty's Colonies or Plantations in *America*, and to reſtrain the Number of Apprentices taken by the Hat-makers in the ſaid Colonies or Plantations, and for the better encouraging the making Hats in *Great Britain.*

WHEREAS the Art [redacted] Myſtery of making Hats in Great Britain hath arrived to great Perfection, and conſiderable Quantities of Hats manufactured in this Kingdom have heretofore been exported to His Majeſty's Plantations or Colonies in America, who have been wholly ſupplied with Hats from Great Britain; and whereas great Quantities of Hats have of late Years been made, and the ſaid Manufacture is daily increaſing in the Britiſh Plantations in America, and is from thence exported to Foreign Markets, which were heretofore ſupplied from Great Britain, and the Hat-makers in the ſaid Plantations take many Apprentices for very ſmall Terms, to the Diſcouragement of the ſaid Trade, and debaſing the ſaid Manufacture: Wherefore for preventing Preamble.

5 C

41 The Act of Jan. 13, 1731, from the copy printed at London, 1732, in the New York Public Library

RESTRICTION OF COLONIAL HAT MAKING

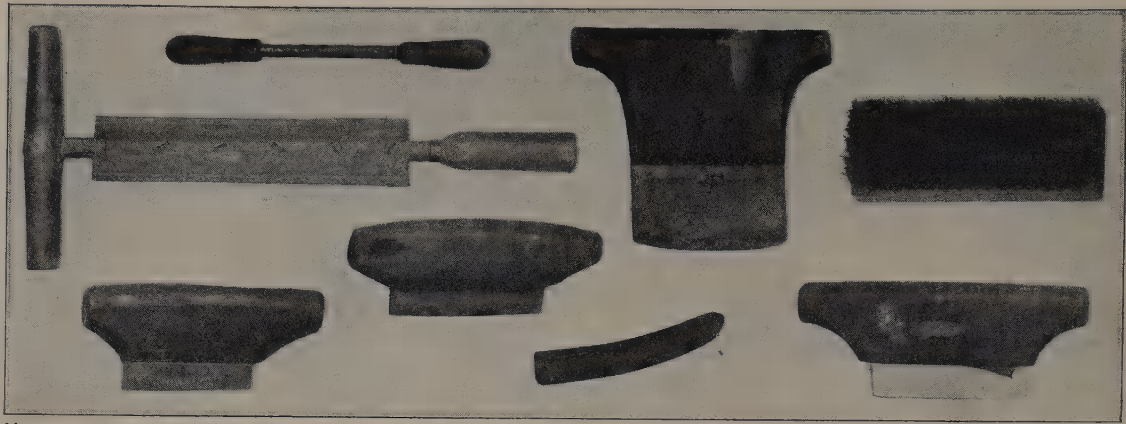
So proficient and diligent, indeed, did American hatters become that they seriously menaced the prosperity of their British contemporaries; these therefore petitioned and procured from Parliament restrictive ordinances against the colonists (No. 41). In spite of restrictions, however, the colonial hatters continued to flourish.

42 From Edward Hazen, *Popular Technology or Trades and Professions*, New York, 1843

43 Felting Hats, from *The Growth of Industrial Art*, Washington, 1892

THE HATTER AT WORK

The first step in the hatter's task was to form a large conical "bat" of loose fur and to wrap it in a wet cloth. He then repeatedly immersed, rolled and beat the "bat" so as to aid the natural cohesiveness or felting of the fur. When sufficiently felted the hat was shaped over a block, hardened with shellac and other substances, dyed, ironed, and finished. It was then sold, perhaps, to one of the colonial gentry. Cheap hats made from wool were formed into a "bat" by the aid of varnish-like materials. Such less expensive head coverings adorned the plain folk of the farms and villages. These early hat makers were among the first to feel the effect of the jealousy of the contemporary rivals in England. But despite restrictive measures, their trade thrived.



44 Set of Currier's Tools, in the collection of the Pocumtuck Valley Memorial Association, from a photograph by S. G. Holden

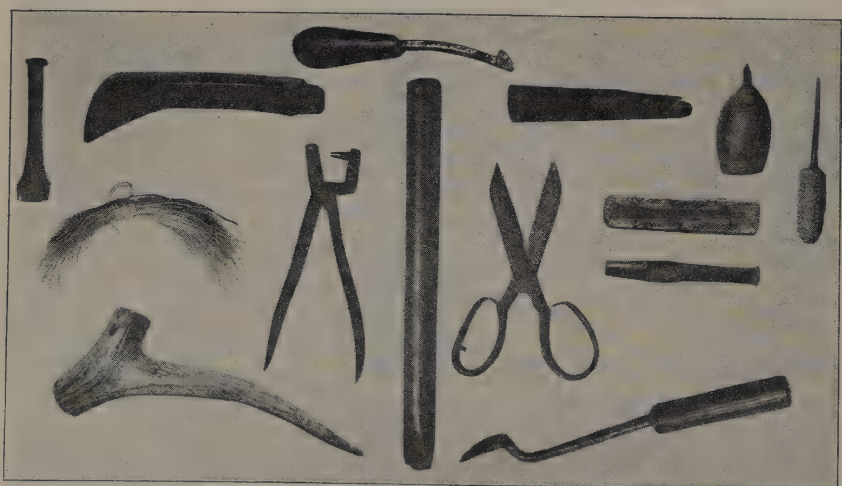
THE CURRIER

Leather workers, too, were important colonial craftsmen. Leather fresh from tanning is stiff and brittle, and a currier had to prepare it before it could be used. He immersed the raw leather in various solutions that dyed it, and filled its pores with softening yet preservative substances. These were worked into the leather, and any wrinkles were worked out of it by brushing, scraping, and rolling with hand implements. In modern practice the work of the currier is done by machinery at the tannery itself; the currier's laborious craft, so widespread in the eighteenth century, has almost disappeared.

45 An Early Currier, from *The Growth of Industrial Art*, Washington, 1892

A HARNESS MAKER'S TOOLS

Much of the leather that the currier prepared went to the harness maker. Horses and, sometimes, oxen used harness that had to be strong to withstand the heavy strains and the rude shock of work on the farm or in the forest. Harness became more and more complex, and an expert was required for its manufacture. While his craft was vastly different, the harness maker's tools, especially those for cutting and stitching, differed little from the outfit of the traveling shoemaker. With these he stitched the broad collars and the tough traces that hauled the load, or with them he shaped the ornaments on the gear of the coach horse.



46 From the collection of the Pocumtuck Valley Memorial Association

47 From Edward Hazen, *Popular Technology*, etc., New York, 1843

48 Saddler's Sewing Horse, in the collection of the Pocumtuck Valley Memorial Association

THE SADDLER

ANOTHER worker in leather was the saddler. He did his work seated on a "horse," with the material in front of him clamped into a wooden vise, held taut by a leather strip fastened to a stirrup, or kept in place by the pressure of the knees. Like other artisans, he inherited his skill from the trades of mediæval Europe. Like his fellow artisans also he had a pride of craftsmanship which the workers of a later machine civilization have lost. Nor did he lack for business, for in days when roads were often little more than traces through the woods he who would travel must go on horseback.

THE DISTILLER

COLONIAL America was an age of heavy drinking. Almost every farmer in settlements old enough for apple trees to have matured made, each fall, a quantity of cider. The Germans who came in the eighteenth century to the middle and southern colonies almost universally brewed beer. In Puritan New England sprang up the important industry of distilling rum from imported West Indian molasses. Rum was an essential part of the stores of New England ships, for ship captains doled equal allotments of this beverage along with sea biscuits to the crew. Rum was also a most important help to the captain in securing a hold full of likely negroes on the African coast. From earliest times brewing and distilling represented the investment of relatively large amounts of capital and the employment of many men. Brewers and distillers helped to swell the ranks of the artisans. New England resentment was great when, in 1733, England passed the Molasses Act, which sought to prevent the colonists from trading with the sugar-producing West Indies.

49 From Edward Hazen, *Popular Technology*, etc., New York, 1843

50 From Edward Hazen, *Popular Technology*, etc., New York, 1843

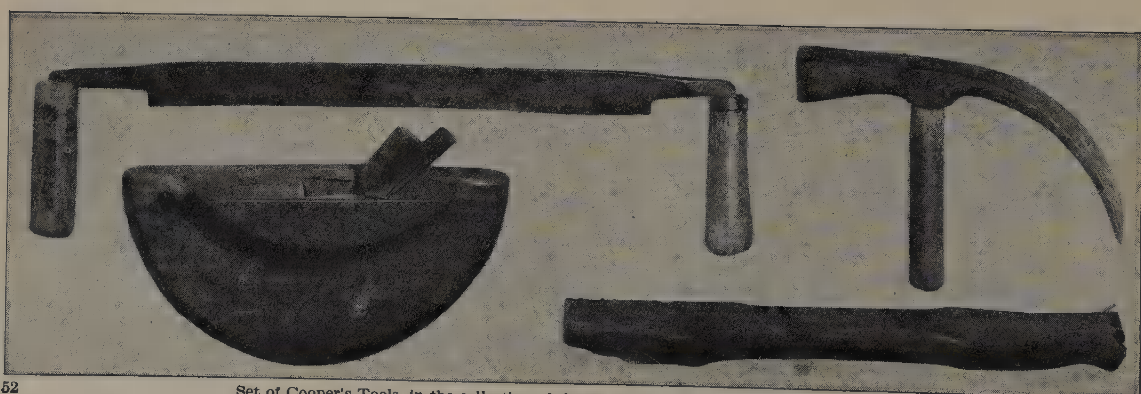
THE DYER

The stinking dye pot was one of the banes of the pioneer wife, tolerated by her because it was necessary. Gladly the housewife gave up the nauseating task of dyeing to professional artisans as soon as dyers appeared. The dye-house, dangerous because of its slippery wet floors and sunken tubs invisible in heavy steam from the vats, and full of the odors of operation was a building to be shunned. Yet the dyer's skill was great and the demand for his work insistent, so that the craft was especially well paid.

THE COOPER

With fish, rum and whale oil as exports and sugar or molasses as imports, the commerce of the New England and Middle Atlantic colonies created a large demand for casks, vats, and barrels. Other commodities such as shoes, money, or tobacco were also sent to sea in the products of the cooper's trade. In all seaports and a few interior towns near the wood supply, the cooper was an important artisan; his shop was sought out by merchants who handled many different products. Staves and hoops, knocked down and bundled, were frequently part of the cargoes of outgoing ships.

51 A Cooper at Work, from Edward Hazen, *Popular Technology*, etc., New York, 1843



52 Set of Cooper's Tools, in the collection of the Pocumtuck Valley Memorial Association

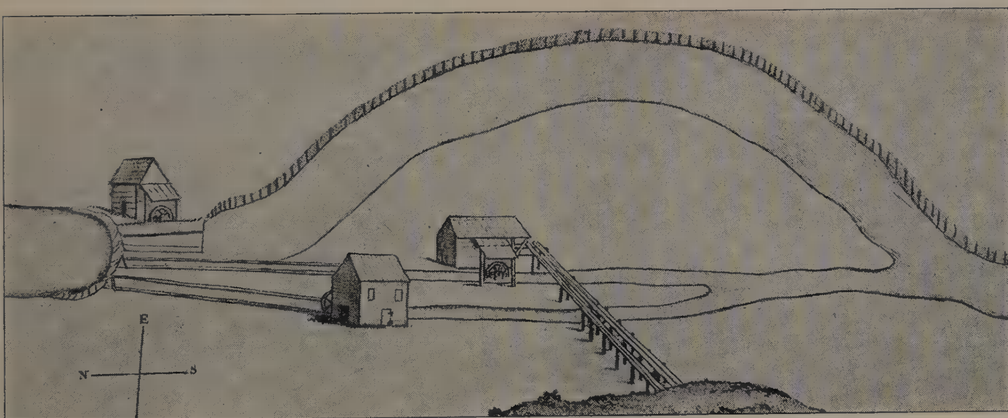
THE ROPEMAKER

Rope, so essential in ship's gear, was manufactured at most colonial seaports. "Ropewalks" were sometimes a quarter of a mile long, the workman weaving the strands together while he walked slowly along. The finished rope was wound on a wheel at the end. To-day rope-weaving machines for even the largest cables take up only a relatively small space.

53 From Edward Hazen, *Popular Technology*, etc., New York, 1843

SAWMILL AND GRISTMILLS AT NEW EBENEZER, GEORGIA, ABOUT 1740

One of the most important of the crafts of the colonies was that of the miller. On countless streams, from Maine to Georgia, might be seen the mills so essential to the life of the early settlements. The New Ebenezer mills, built on a branch of the Savannah River, are typical. Two are gristmills, primarily intended for rice; the third, approached by a bridge, is a sawmill. The water wheel of the sawmill is of crude type operated by the current striking against vanes on the under side, and called an "undershot" wheel. The bridge leading to the sawmill was a local necessity and not an integral part of such an enterprise, and was used in this case to convey large logs from the high land to the mill itself. The association of gristmills and sawmills was a common feature everywhere in colonial America. Traces of such old mills may still be seen at the bend of many a creek and river.



54 From *Ulsperger Tracts*, Augsburg, *ca.* 1740, in the John Carter Brown Library, Providence, R. I.

A PRIMITIVE SAWMILL IN OHIO

The sawmill of the frontier was often extremely crude. Yet pioneers had so much work for their hands that any mechanical aid, regardless of its crudity, was a blessing early sought and eagerly utilized.

55 From J. S. Buckingham, *The Eastern and Western States of America*, London, 1842, after a drawing by W. H. Bartlett

56 © Rau Studios, Inc.

A PIONEER GRISTMILL

Gristmills were made of logs or lumber and sometimes of brick or stone, according to the materials at hand and the artisans capable of working them. As a social center the gristmill ranked almost with the church. The miller, if he chose to be, was a powerful political figure, for to him came many men bringing the news and gossip and the problems of the locality. Just as in manorial England, the miller, while he neither sowed nor reaped, frequently became in colonial America the wealthiest and most influential citizen in the community.

AN OLD MILLSTONE

The huge millstone was often hard to obtain. An isolated village used, of course, whatever stone it could get; but a community on navigable water brought desirable stones from relatively long distances. Some were even procured from overseas. The Deerfield stone was quarried from Mount Tom in 1693 and set up in the mill at Mill River.

57 From the collection of the Pocumtuck Valley Memorial Association

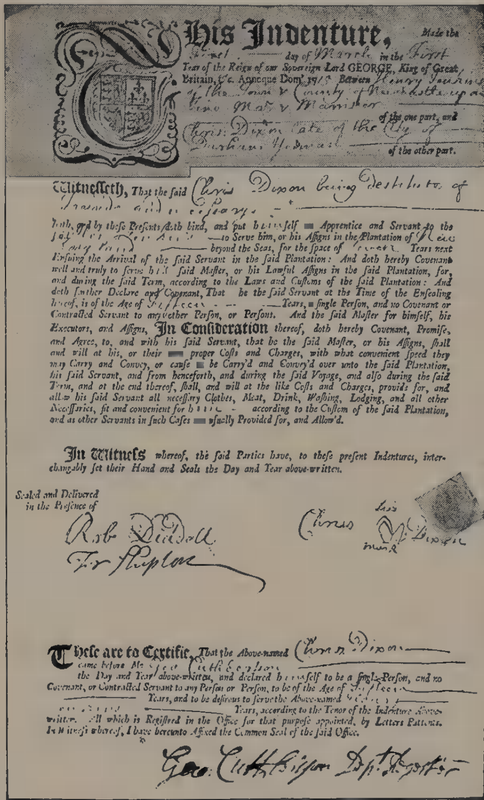
58 From J. Milbert, *Itinéraire Pittoresque du Fleuve Hudson*, etc., Paris, 1828–29

SAWMILL AT GLENS FALLS, NEW YORK, 1826

In the course of time Americans ventured beyond the tiny rivulets from which they derived their first power and boldly set about the conquest of larger streams with greater power possibilities. The placing of a sawmill on the edge of Glens Falls, New York, called for no small degree of engineering courage. The harnessing of such a river meant that the phase of industrial evolution dominated by the craftsman who worked with his hands was passing away, merging into that in which natural forces drove the factory machines that, in the nineteenth century, steadily supplanted the old-time artisan.

AN APPRENTICE'S INDENTURE, 1715

THE indenture of Chris. Dixon, aged fifteen, of Durham, England, who, being "destitute of friends and necessarys," was "sold" as an apprentice and servant for seven years, illustrates not only the manner in which the colonies eked out the scanty labor supply but a way of educating a boy to a trade. Some of these indentured servants were of good family, but all were in dire straits and taking a desperate chance to gain a fresh start in a new country. Their lot, while their indenture lasted, was not very different from that of slaves of the same neighborhood, but it involved no social disgrace that could not be lived down by good behavior and later success. Many of the artisans of more or less skill were from this class. Often the indentured servant made his escape and found freedom and opportunity on the frontier. The English system of apprenticing children until they were of age was transferred bodily to America. Though liable to abuse, this system turned out artisans who knew their business.



This Indenture, Made the First day of March in the First Year of the Reign of our Sovereign Lord GEORGE, King of Great Britain, &c. Annoque Dom' 1715 Between Henry Jenkins of the Town & County of Newcastle upon Tyne Mast. & Mariner of the one part, and Chris: Dixon late of the City of Durham, Yeoman of the other part.

Witnesseth, That the said Chris Dixon being destitute of friends and necessarys doth, and by these Presents doth bind, and put himself Apprentice and Servant to the said Henry Jenkins to Serve him, or his Assigns in the Plantation of New England beyond the Seas, for the space of Seven Years next Ensuing the Arrival of the said Servant in the said Plantation: And doth hereby Covenant well and truly to serve his said Master, or his Lawful Assigns in the said Plantation, for, and during the said Term, according to the Laws and Customs of the said Plantation: And doth further Declare and Covenant, That he the said Servant at the Time of the Ensealing hereof, is of the Age of Fifteen Years, a single Person, and no Covenant or Contracted Servant to any other Person, or Persons. And the said Master for himself, his Executors, and Assigns, In Consideration thereof, doth hereby Covenant, Promise, and Agree, to, and with his said Servant, that he the said Master, or his Assigns, shall and will at his, or their proper Costs and Charges, with what convenient speed they may Carry and Convey, or cause be Carry'd and Convey'd over unto the said Plantation, his said Servant, and from henceforth, and during the said Voyage, and also during the said Term, and at the end thereof, shall, and will at the like Costs and Charges, provide for, and allow his said Servant all necessary Clothes, Meat, Drink, Washing, Lodging, and all other Necessaries, fit and convenient for him according to the Custom of the said Plantation, and as other Servants in such Cases usually Provided for, and Allow'd.

In Witness whereof, the said Parties have, to these present Indentures, interchangably set their Hand and Seals the Day and Year above-written.

Sealed and Delivered in the Presence of
Rob Diddell
Fr Shiplow

Chris his mark Dixon

These are to Certifie, That the Above-named Chris Dixon came before Me Geo Cuthbertson the Day and Year above-written, and declared himself to be a single Person, and no Covenant, or Contracted Servant to any Person or Persons, to be of the Age of Fifteen Years, and to be desirous to serve the Above-named Years, according to the Tenor of the Indenture Above-written. All which is Registred in the Office for that purpose appointed, by Letters Patents. In Witness whereof, I have hereunto Affixed the Common Seal of the said Office.

Geo: Cuthbertson Dept. Register

59 From an original indenture in the Hingham Historical Society

THE COUNTRY PEDLAR

As the eighteenth century drew to a close, more and more artisans sold the products of their handiwork to pedlars who vended them in the country districts. These pedlars persisted into the day of the early factories. This first national distributing system was largely responsible for the early and continued preëminence of southern New England in the manufacture of "Yankee notions," a term applied to a myriad of small articles made from metal or wood. The Connecticut Yankee, bareboned and shrewd, was the first colonial pedlar. On his own back, afoot or on horseback, or atop cleverly designed wagons full of ingenious compartments, he carried his wares into the remotest regions. With his stock of tinware, brassware, watches, clocks, pins, woodenware, brooms, baskets, "ribbons and laces to set off the faces of pretty young sweethearts and wives," it is no wonder that the pedlar's visits were occasions of excitement, long awaited and never to be forgotten. Novelties from the city, necessities, and news arrived at the homestead door together.

60 From *Harper's Weekly*, June 20, 1868, after a drawing by C. G. Bush

A RELIC OF THE PAST

THE scissors grinder and umbrella mender whose clanging bell still sounds on city streets is a type of early itinerant craftsman who has not disappeared with the changing years. Like the crumbling dams and ancient water wheels along the streams he represents a stage of industrial progress which has forever passed.

61 From *Cries of New York*, New York, 1808, woodcut by Alexander Anderson

CHAPTER III

THE RISE OF THE FACTORY SYSTEM

THE evolution from the self-sustaining English manor, or in America the equally self-sustaining southern plantation and northern farm, is marked by several stages. First came the village, in both England and America; its streets, in addition to such part of the farming or seafaring population as might be settled there, were bordered by the homes of artisans or specialists such as the merchant, the tavern keeper and the apothecary. Although in each home much general work was carried on, each tended more and more to specialize in a particular product. Another stage was reached when to the gristmill, most ancient of factories, were added tanneries, fulling mills, and the like, supplementing the home industries. Slater's spinning factories mark a further step; here the machines spun yarn which was woven into cloth in the homes. This stage still persists to-day in some regions in the hat, button, and garment trades. Finally the present stage became general, in which the home becomes merely a place to eat and sleep, and the huge factory each morning whistles its long line of workers to their tasks and disgorges them again at evening. The sprawling squalid factory town of the nineteenth century had lost much of an earlier dignity and beauty, which the twentieth century has in places striven to restore.

The factory system originated in England, the product of the Industrial Revolution. Its transfer to America was slow. Americans were too much absorbed in agriculture and the sea trade to be able to shift quickly to manufacturing. A number of other factors held them back. In 1807, however, occurred an event of prime importance for the establishment of factories in the United States. England and France were fighting a titanic struggle. The merchant marine of both had suffered from the conflict while that of neutral America had reaped large profits. In 1807 each belligerent sought to prevent the other from being served by the ships of the United States. A series of Orders in Council by the British government and Decrees by Napoleon struck a heavy blow at American trade with Europe. President Jefferson determined to retaliate.

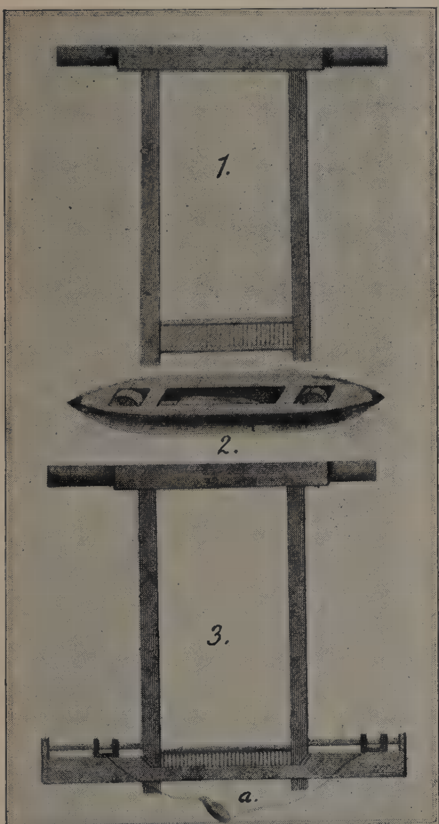
In spite of the opposition of the shipping interests of the nation Jefferson secured the passage, in 1807, of the famous Embargo Act. In accordance with the provisions of this measure American ships, with certain specified exceptions, were tied up at American wharves. Jefferson sought to bring England and France to terms by economic pressure. In this he failed, and suffered the humiliation just before he retired from the presidency of signing the repeal of the measure from which he had hoped so much. The embargo brought great losses to the merchant marine. Three years after its repeal the nation, under the leadership of President Madison, embarked upon the War of 1812. For eight years, from the establishment of the embargo to the Treaty of Ghent in 1815, America was isolated more or less completely from English manufacture. During this period, when manufacturing became a patriotic duty, the factory became established in the United States. Many of these first enterprises, to be sure, failed when foreigners dumped their goods here after the war, but enough remained to start our industrial career.

A FIRST STEP TOWARD THE FACTORY SYSTEM

THE distinguishing marks that set off the factory from household manufacture are the separation of the worker from the ownership of tools or means of production, the collection of many workers under one roof, the development of machinery, and the application of power.

62 From the series *Industry and Idleness*, drawn and engraved by William Hogarth (1697–1764), reëngraved by T. Cook

In the eighteenth century, decades before machinery was perfected or mechanical power substituted for muscle, more than one enterprising person both in Britain and America saw the advantage of collecting in one place many workers of a like kind. This form of production brought savings in time and material since both workmen and products, raw and finished, were constantly under the eye of the owner. An increased output, too, was developed by the stimulation of competition among rival workmen and the exhortations of the overseer, and finally, savings were made by means of subdivision and specialization of work. In addition to these general incentives toward concentration of manufacture particular trades found further advantages in the scheme. Thus whitesmiths working with precious metals could ill afford individually the expense of purchasing their own raw material, and turned to the capitalist, who purchased the metal and sold the products. To protect himself against theft or loss the capitalist gathered the smiths together in one building where they and the valuable stuffs they used could be easily supervised. Likewise the weight and expense of knitting frames or looms tended to concentrate the workers at knitting and weaving. From conditions of this sort arose the first approaches toward the factory system.



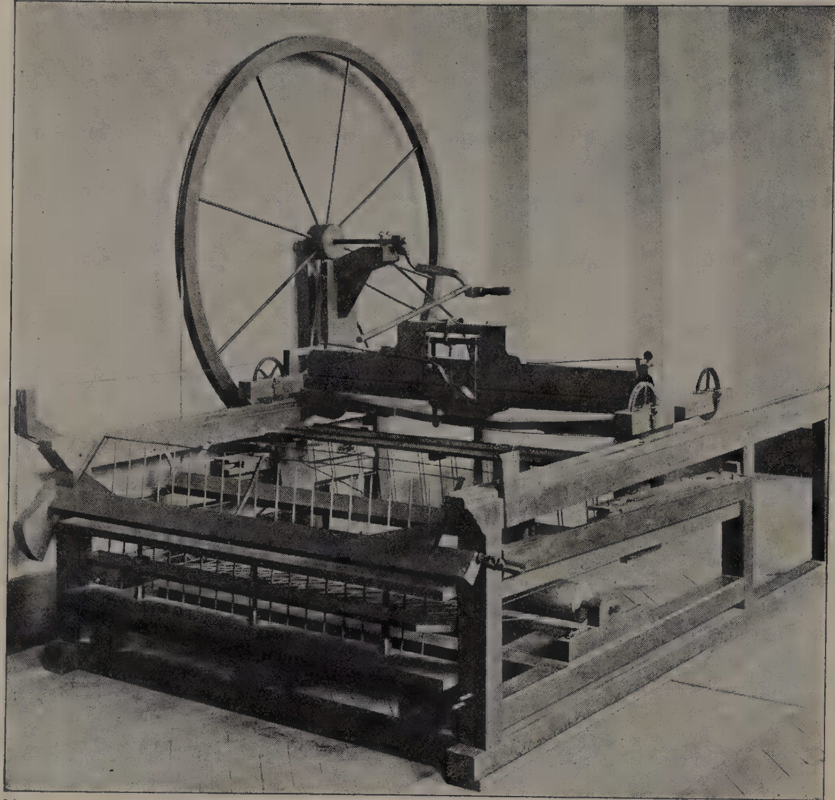
63 From Richard Guest, *A Compendious History of the Cotton Manufacture*, Manchester (Eng.), 1823

THE FLYING SHUTTLE

THE factory system is a British rather than an American innovation. It appeared first in the British textile industry and with astounding speed transformed the organization of that trade. For centuries social classes, living conditions, craft practices and wages had been held closely within the bounds of traditional customs; then swiftly, within fifty years, the new system burst through the shackles of the old and became dominant. This change was begun by a series of English inventions for cotton manufacture, and is called by historians the "Industrial Revolution."

John Kay, in 1733, invented the flying shuttle, which, by means of two cords, alternately pulled and threw the shuttle bearing the weft back and forth across the warp threads. This was not only faster than the old method of passing the shuttle by hand, but in the case of broadcloths it displaced one man, where previously two had been required, one at each side of the loom, to pass the shuttle to and fro. The threat of being thrown out of work by this device caused Kay's neighbors to invade his house, break his machine, and put his life in jeopardy.

Figure 1 shows the lathe used when the shuttle was thrown by hand. 2 is the shuttle invented by Kay. 3 is Kay's lathe on which the shuttle (*a*) was passed from left to right by means of cords.



64 From a replica in the South Kensington Museum, London

HARGREAVES' SPINNING JENNY, 1770

James Hargreaves, poor and untutored, by turns a spinner, weaver, and carpenter, is generally credited with giving the first important impulse to the wave of textile inventions that revolutionized Great Britain in the latter half of the eighteenth century.

Hargreaves' principal contribution to textile art was a spinning machine which spun eight threads at once. The origin of this mechanism is shrouded in legend. It is said that Hargreaves startled his wife (some say his small daughter), causing her to upset her spinning wheel, which continued to whirl horizontally with its spindle in a vertical position. This gave Hargreaves the idea of a machine containing multiple spindles actuated by one wheel. On making the machine, so the story goes, he called it a "Jenny" after his wife (or daughter). The machine was patented in 1770, although invented some years earlier.

Spinning jennies with thirty or more spindles operating at once came into use despite the fierce opposition of hand spinners. From the national point of view, multiple spinning was a great boon because cloth production, a mainstay of British commerce, had been checked by the lack of yarn, one weaver keeping a dozen spinners fully occupied.

SIR RICHARD ARKWRIGHT, 1732–92, FATHER OF THE FACTORY SYSTEM

Richard Arkwright, one of thirteen children, starting in trade as a barber at Bolton, England, contributed more than any other one man to the establishment of the factory system by his many inventions and improvements in textile machinery. Unlike many inventors Arkwright was able to accumulate a fortune worth some two million dollars, a vast sum for the eighteenth century, by becoming a manufacturer and using his own inventions. In recognition of his services to his country, and regardless of the fact that he could hardly read or write, he was knighted by his king in 1786. When he died, in 1792, he had a castle, built by his orders at Willersby, England, nearly ready for his occupancy.

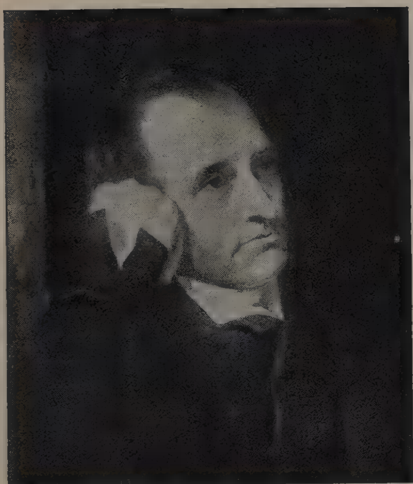
65 From the portrait by Joseph Wright of Derby (1734–97) in the National Portrait Gallery, London

ARKWRIGHT'S SPINNING FRAME, 1769

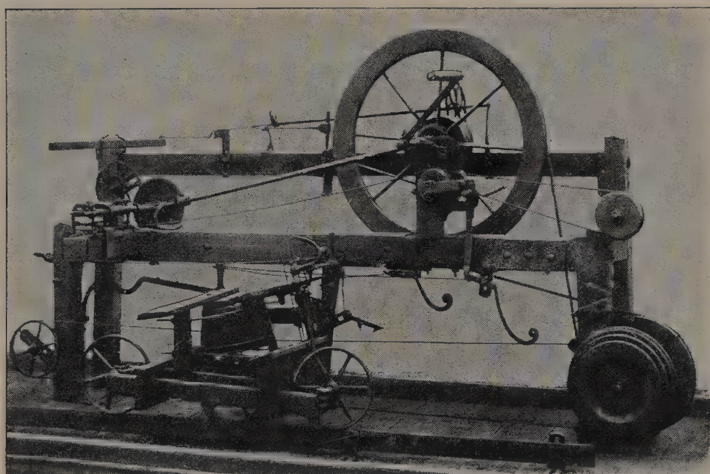
ARKWRIGHT'S first of many inventions was his spinning machine, patented in 1769. Lewis Paul, John Wyatt, and Thomas High had failed in the attempt to draw (stretch) and spin cotton by means of successive rollers each operated at an increasing speed. Warned by their mistakes, or by his own native genius avoiding them, Arkwright produced a successful spinner operating on the roller principle. Protecting it with a patent (later annulled), he set up the first cotton mill in the world at Nottingham. The power was furnished by horses; but in another mill built in 1771, at Cromford, Arkwright used water power to turn his spinners. These latter spinners were improvements over the first and became known as "Arkwright's water-frames."

Eventually Arkwright perfected a whole series of cotton machines, comprising a carding machine for laying the fibers parallel, a roving machine for combining the fibers into a rope and stretching them, and a drawing frame that continued the operation of the roving machine. These machines precede the spinner in the actual order of operations in yarn manufacture, although they were invented after it.

66 From the original in the South Kensington Museum, London



67 Samuel Crompton (1753–1827) from the portrait, about 1802, by Charles Allingham in the Hall-in-the-Wood Museum, Bolton, England

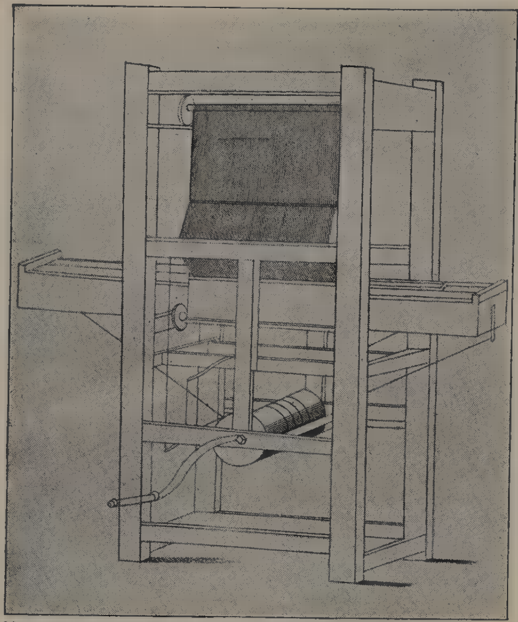


68 Crompton's Mule, from the working model in the Chadwick Museum, Bolton

THE SPINNING MULE

BROUGHT up by a shrewish mother and an invalid uncle under conditions of comparative poverty, Samuel Crompton was forced to labor at spinning from earliest childhood. Desiring the leisure for study and music not allowed by the demands of his task, Crompton turned his thoughts to the improvement of the spinning mechanism. For five years (1774–79) he experimented at night after the close of the day's work to discover a better method of spinning. The successful result was the "mule," one of the three most significant textile inventions. Having no aptitude for business affairs, Crompton realized little pecuniary reward from his device, a story too true of many other inventions.

Hargreaves' jenny was useful in spinning soft weft yarns, Arkwright's water-frame produced excellent hard warp yarns, but neither was able to turn out the finest yarns useful for either warp or weft. Crompton's invention combined the features of the two machines of his predecessors, one of them the jenny, hence the Crompton device was called a "mule." Since it spun the finest of yarns it was also named "the muslin wheel." Before Crompton, the finest fabrics were made with a warp yarn spun by East Indians or with fine linen yarn. The mule produced fine cotton warps and gave Britain at once the leadership in the production of fine goods.



69 From Cartwright's original patent specifications, April 4, 1785, published by the British Patent Office

CARTWRIGHT'S LOOM, 1785

The deficiency in yarn that had long retarded British textile production having been more than made up by the inventions of Hargreaves, Arkwright and Crompton, the scale began to turn against weaving. For the first time the old hand loom was unable to keep pace with the output of yarn. Men's thoughts therefore turned to a power loom.

Edmund Cartwright, minister in the Church of England, although knowing very little of mechanics and never having seen a loom at work, was nevertheless the successful inventor in 1785 of a loom operated by mechanical power. This loom he gradually brought to a high state of perfection. In recognition of its value Parliament voted him a gift of £10,000 sterling in 1809, with which he bought an estate, turned gentleman farmer, and applied his genius to inventing agricultural tools.

70 From John C. Cobden, *Sufferings of the English Poor, or The White Slaves of England*, Auburn, N. Y., 1853

EARLY ENGLISH FACTORY CONDITIONS

When the cotton factory was introduced into England, British labor was at the lowest ebb of its fortunes. Country labor had been thrown off the farms by the enclosures first for sheep farming and later for more scientific agriculture. The factory system itself took away the employment of domestic artisans and destroyed what little remained of the craft guild system. With all their refuges and customary aids — such as the use of the commons — done away, and with the law or custom favoring the support of labor by charity, a goodly proportion of British labor were living as paupers. Crime and immorality were rife. This should be borne in mind in order to get a proper perspective upon the conditions of labor in the early British mills. Almshouses were made to give up their children to the factories, crowds of people were huddled into living quarters unprepared for such hordes, sanitation and humanity were ignored, immorality taken for granted. In the mill long hours prevailed, working conditions were deplorable, and harsh treatment was customary. Wages were at the barest subsistence level. There is no darker blot in British history than the treatment of labor both inside and outside of the mills at the opening of the nineteenth century.

DANIEL MAUSE, Hosier,
At the Sign of the HAND-IN-HAND Stocking Manufactory, on the West Side of Second-street, between Race and Vine-streets, takes this Method of informing the Public,

THAT he has lately erected a Number of Looms, for the manufacturing of Thread and Cotton Stockings, and other Kinds of Hosiery, of any Size or Quality, hoping the good People of this and the neighbouring Provinces, will encourage this his Undertaking, at a Time when AMERICA calls for the Endeavours of her SONS; and as the Goodness of the PENNSYLVANIA MADE STOCKINGS is so well known, and so universally esteemed, said MAUSE will work up THREAD, COTTON, WORSTED, YARN, &c. in the best Manner for the Country, Gentlemen, or others, who may be pleased to employ him, for a moderate Satisfaction. He gives the best Prices for THREAD, COTTON, WORSTED and YARN, of the Produce and Manufacture of AMERICA only. The above Person from his Experience, and Travels in Quest of Improvement, with Intent of establishing a respectable Manufactory in PHILADELPHIA, presumes to offer his Services as above, steadily determined to work well, and at the most reasonable Rates.

N. B. The Stockings made at the aforesaid Manufactory, are to be sold there, and by THOMAS BOND, jun. and Company, at their Store; where Orders will be received, and duly executed.

6 1 W.

71 From the *Pennsylvania Gazette*, Philadelphia, May 1, 1766

ADVERTISEMENT OF A WEAVER, 1766

In America, meanwhile, the transition from home industry to the factory system was likewise going on. Energetic capitalists were collecting spinners and weavers into one building and offering the products of their labor to the public. The Stamp Act (1765) and the Townshend tax measures (1767) were met by a boycott of English goods. The necessity for home production hastened the tendency toward concentration. Daniel Mause, hosier, one of these early American manufacturers, went into business soon after the passage of the Stamp Act.

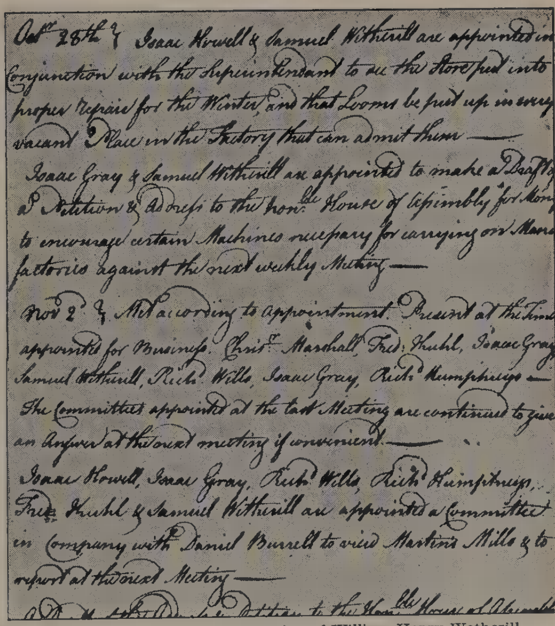
72 From a silhouette in the possession of William Henry Wetherill, Philadelphia

SAMUEL WETHERILL, 1736–1816, PIONEER AMERICAN TEXTILE MANUFACTURER

ALTHOUGH America was not blind to the industrial revolution which was occurring in England as a result of the efforts of a barber, a violinist, a minister, and a tutor, British law forbade the exportation of the new machines, any parts of them, or even plans. English artisans skilled in the use of the mechanisms were denied the privilege of emigration. America, too, was well-nigh bankrupt as a result of the Revolution. Its scanty capital was tied up in farming and commerce, overwhelmingly the occupations of the people. It was not until commerce was temporarily stopped by the Embargo Act of 1807, the Non-Intercourse Act of 1809 and particularly by the War of 1812, that the factory system already begun in America had a real chance to start on the road of development which England had long followed. One of the pioneers of this movement was Samuel Wetherill, Jr., a far-sighted Quaker merchant of Philadelphia, who, together with a number of other merchants, founded in 1775 "The United Company of Philadelphia for promoting American Manufactures." This company set up in the same year a factory in a house at the corner of Ninth and Market Streets, Philadelphia. In this factory was an adaptation of the Hargreaves jenny. The project was abandoned when the British captured the city in 1777.

THE MINUTE BOOK OF THE UNITED COMPANY OF PHILADELPHIA

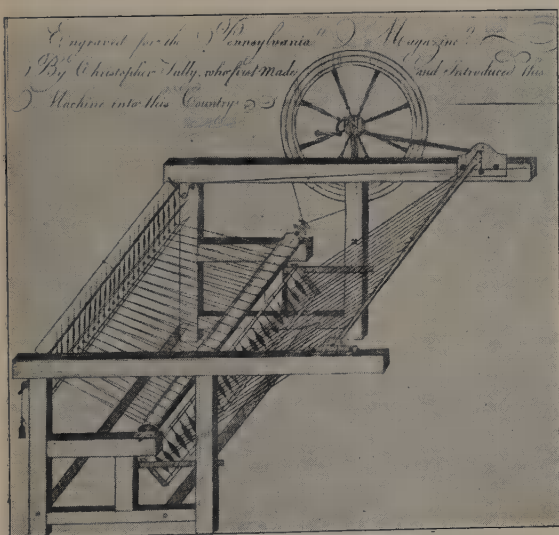
THE records of the United Company were carefully kept, and during the first months were systematically written by Samuel Wetherill himself. The minute book with the record in his own handwriting still exists. The page shown is taken from the minute book, under dates of October 28–November 2, 1775.



Octr 28th } Isaac Howell & Samuel Wetherill are appointed in Conjunction with the Superintendant to see the Store put into proper Repair for the Winter, and that Looms be put up in every vacant Place in the Factory that can admit them —
Isaac Gray & Samuel Wetherill are appointed to make a Draft of a Petition & Address to the honble House of Assembly for Money to encourage certain Machines necessary for carrying on Manufactories against the next weekly Meeting —

Nov 2 } Met according to appointment. Present at the Time appointed for Business. Christr Marshall, Fred: Kuhl, Isaac Gray, Samuel Wetherill, Richd Wills, Isaac Gray, Richd Humphreys —
The Committees appointed at the last Meeting are continued to give an Answer at the next meeting if convenient —
Isaac Howell, Isaac Gray, Richd Wills, Richd Humphreys, Fredk Kuhl & Samuel Wetherill are appointed a Committee in Company with Daniel Burrell to view Martins Mills & to report at the next Meeting —

73 From the original in the possession of William Henry Wetherill, Philadelphia



74 From the *Pennsylvania Magazine*, Philadelphia, 1775, after an engraving by Christopher Tully

THE FIRST KNOWN AMERICAN SPINNING JENNY

THE jenny used by Samuel Wetherill in his factory had been constructed by Christopher Tully and was exhibited in Philadelphia in 1775. This machine is said to have been the first to be made in America from a model of Hargreaves' invention. An engraving of the machine was published in the *Pennsylvania Magazine* about the time Wetherill took it over. It must be added that the Tully jenny was not successful, and that Wetherill had to depend on the old, tried methods of making cloth.

75 Label of Samuel Wetherill, from a copperplate formerly in the possession of Miss Rachel Wetherill, Philadelphia

EXPANSION OF THE WETHERILL ENTERPRISE

After the War of Independence, Samuel Wetherill continued the manufacture of textiles, as shown by an advertisement of his goods printed in 1782. The label which he used shows the old hand spinning wheel. In 1787 the Society for the Encouragement of the Useful Arts was formed in Philadelphia, an outgrowth of the United Company and of the Wetherill enterprise. Among its most influential members, in addition to Wetherill himself, was Tench Coxe. The society took over the house of the old United Company and set up its first loom in 1788. This enterprise contests with the Beverly experiment for the honor of being the first textile factory in America.

Philadelphia Manufacture,
Suitable for every SEASON of the YEAR, viz.
JEANS, FUSTIANS, EVERLASTINGS, COATINGS, &c. to be sold by the subscriber, at his dwelling-house and manufactory, in South-alley, between Market-street and Arch-street, and between Fifth and Sixth-streets, on Hudson's square.
§ SAMUEL WETHERILL.

76 Advertisement of the Wetherill Factory, from the *Pennsylvania Gazette*, April 3, 1782

Several publick-spirited gentlemen in Beverly have procured a complete set of machines for CARDING and SPINNING COTTON—with which an experiment was made, a few days ago, which answered the warmest wishes of the proprietors. The spinning jenny spins 60 threads at a time; and with the carding machine, 40lb. of cotton can be well carded in a day—— The warping machine, and the other tools and machinery (part of which go by water) are all complete——perform their various operations to great advantage, and promise much benefit to the publick, and emolument to the patriotick adventurers.

It is with pleasure we have so frequent occasions to take notice of the progress of Arts and Manufactures in our country: The genius of the Americans for invention and execution, in these respects, together with their perseverance in agriculture, and enterprise in commerce, will doubtless, ere long, if not checked by the want of a wise federal government, raise them to a respectable station in the scale of emp[illegible].

77 From the *Salem Mercury*, April 22, 1788

THE BEVERLY MANUFACTORY, 1788

Meanwhile the Legislature of Massachusetts was lending encouragement in the form of money allowances to Robert and Alexander Barr and Thomas Somers, three Scotchmen who claimed a knowledge of cotton manufacture. As a result of their labors the state acquired models of textile machines, and a venture was made at Beverly in actual manufacturing. The Beverly plant was the first cotton mill in New England and disputes national priority with the Philadelphia enterprise.

A newspaper notice of the Beverly mill (No. 77) was published by the *Salem Mercury* on April 22, 1788. The uncertain years following the Revolution and before the framing of the constitution made difficult the establishment of factories.

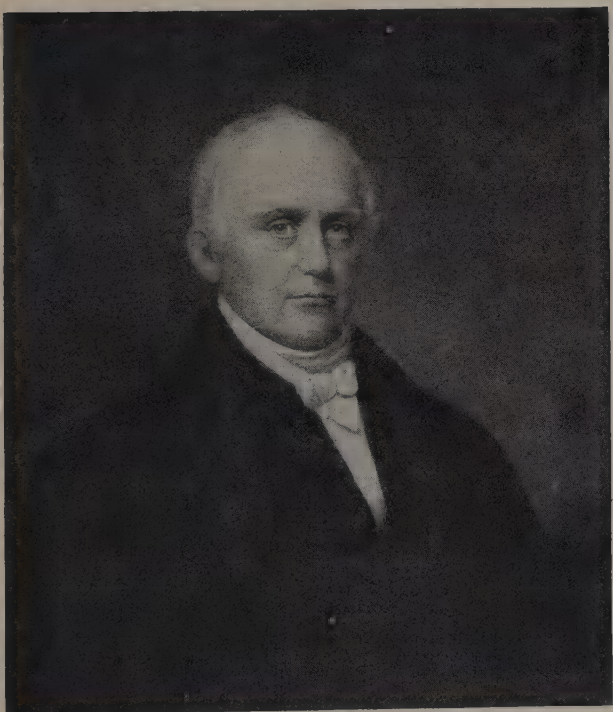
WASHINGTON VISITS THE BEVERLY MILL, 1789

78 From a drawing by George Elmer Browne (1871–) in the Essex Institute

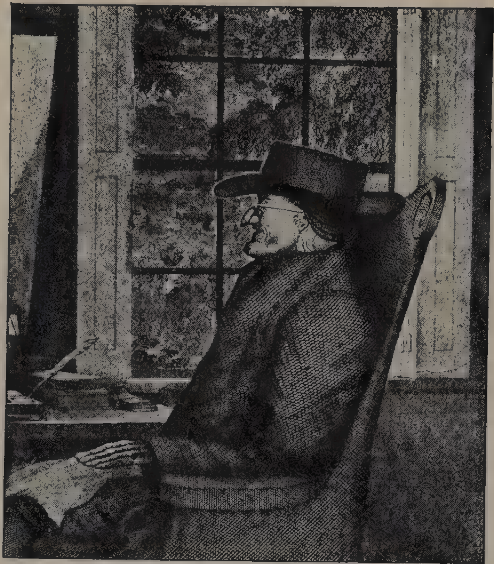
THE Beverly mill, built within 100 feet of the Beverly Tavern, was finished early in 1789. The *Salem Mercury* described it as "a plain three story building of brick, measuring about sixty by twenty-five feet with a pitching shingled roof, and a deep basement in one end of which moved a heavy pair of horses to furnish rotary power." Separated from the mill itself but adjoining it was a small wooden dyehouse. In 1789, President Washington on his way to Portsmouth, while on his tour of New England, stopped at Beverly and made an inspection of the mill. Meeting with continued hardships the enterprise at Beverly was discontinued in 1807 and the mill itself was destroyed by fire in 1828.

SAMUEL SLATER, 1768–1835, FATHER OF THE AMERICAN FACTORY SYSTEM

THE Beverly and Philadelphia enterprises were merely experiments. The actual introduction of the factory system into this country was made by Samuel Slater. Born in Derbyshire, England, in 1768, Slater learned cotton manufacture as an apprentice to his father's friend, Jedediah Strutt, a partner of Arkwright. Inspired by accounts of the efforts of Americans to acquire the textile machines and realizing the fortune and honor that awaited the successful originator of cotton manufacture in that country, Slater diligently applied himself to master every detail of manufacture. To escape the vigilance of the English authorities Slater embarked for America secretly, and without models or drawings of machinery, landing at New York, November, 1789. It was his intention to go to Philadelphia to claim the bounty offered by Pennsylvania for cotton manufacturing mechanisms. Philadelphia having ignored his appeals for a trial, he fortunately met while in New York a ship captain, who told him of the interest being manifested in New England in cotton manufacture, and especially of the practical curiosity of a Quaker merchant named Moses Brown. After corresponding with Brown, Slater moved to Pawtucket, Rhode Island, where with Brown's financial backing he equipped a mill with a full set of Arkwright machinery, constructed from memory and set up in a building formerly used as a fulling mill. The machinery was set in operation on December 20, 1790. This proved to be the first successful venture of its kind in America, and Slater is now honored as the father of American cotton manufacture. By a curious coincidence the founding of the first successful factory and the establishment of the national government under the Constitution were practically synchronous.



79 From the portrait by T. G. Cole (1803–58) for the Slater Bank, Pawtucket, R. I.



80 From the *New England Magazine*, 1887, after an engraving, 1836, by Pollock

MOSES BROWN, 1738–1836

Moses Brown, who backed Slater, was a member of a merchant firm of three brothers at Providence, Rhode Island. When Moses was thirty-six years old he became a Quaker and immediately freed all his slaves. From that time he combined success in business with philanthropy. He was one of the founders of the New England Friends' School of Portsmouth, N. H., and with his brothers endowed Rhode Island College, now Brown University.

Brown's interest in everything that might prove beneficial to the public had led him to encourage cotton manufacture before the arrival of Slater in America, and he eagerly fell in with the latter's proposals.

THE OLD SLATER MILL, 1793

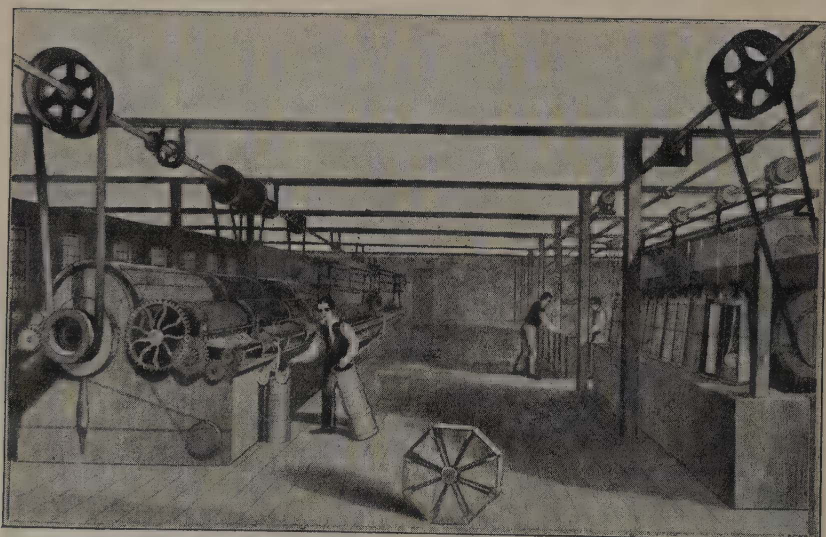
Ezekiel Carpenter's fulling mill proving inadequate for Slater's output, he and his associates built a new mill in 1793, forty feet long, twenty-six feet wide, of two stories and an attic. For over a century the "old Slater Mill" resounded to the whir and clatter of textile machinery, and in its vicinity has grown up one of the greatest cotton mill centers of the world.

81 From the drawing by H. L. Spencer from description by his grandfather, in the possession of Mrs. H. L. Spencer, Bristol, R. I.

THE INTERIOR OF SLATER'S MILL OF 1790

George S. White, in his *Memoir of Samuel Slater*, published a plate which he declared "represents the machinery which Slater erected and operated in the old fulling mill at Pawtucket." It is doubtful whether White ever saw the actual machinery, and he probably copied his view from contemporary English models.

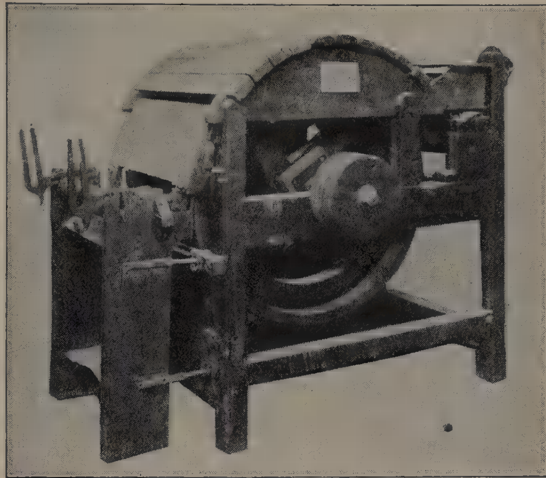
At the left is a carding machine and beyond it a drawing frame. At the right is a spinning machine. Slater had difficulties in making the machines in America. There were few mechanics, and such as there were had little skill. Slater, himself, was compelled to mark out the pattern of every single piece. Making intricate machines from memory under such circumstances was a remarkable feat.



82 From George S. White, *Memoir of Samuel Slater*, Philadelphia, 1836

FIRST COTTON CARDING MACHINE BUILT BY SLATER

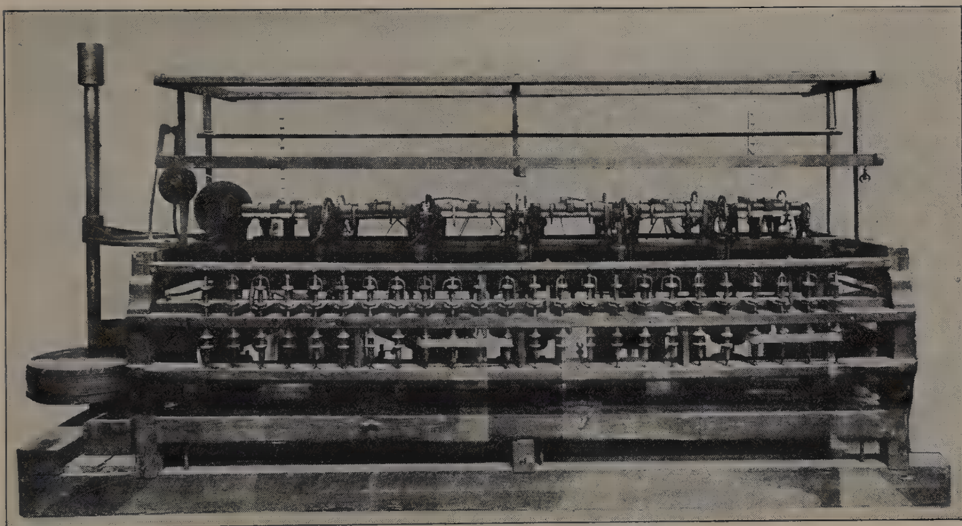
Slater's cotton carder was built after the English design. It was intended to be used for the purpose of arranging loose cotton from the bale in an orderly manner, pulling the fibers until they lay parallel with one another. Slater made this machine without drawings or any other aid except his memory.



83 From the original in the United States National Museum, Washington

SLATER'S SPINNING FRAME, 1790

Slater likewise built his spinning frame from his memory of Arkwright's machinery in England. Mathematical calculations for speeds and feeds, necessary to make this machine run properly, almost ended in failure; but after disappointments he finally achieved a workable mechanism and started America upon its destiny as a manufacturing nation. In this mill was made the first successful attempt in the country to manufacture machine-made cotton cloth. (For Eli Whitney's invention of the cotton gin, 1794, see Volume III, 143.)



84 From the original in the United States National Museum

85 From *The Polyanthos*, Boston, Dec., 1812, after an engraving by J. R. Smith

PAWTUCKET FALLS AND MILLS, 1812

Within three years after the erection of Slater's mill, ten other mills were wholly or partially completed in Rhode Island and before 1808 fifteen mills had been started. The census of 1810 lists 109 cotton mills in New England, three quarters of which were in the Pawtucket and the Blackstone River valleys.

86 From John Warner Barber, *Historical Collections of Massachusetts*, Worcester, 1839

SLATER MILLS AT WEBSTER, MASSACHUSETTS

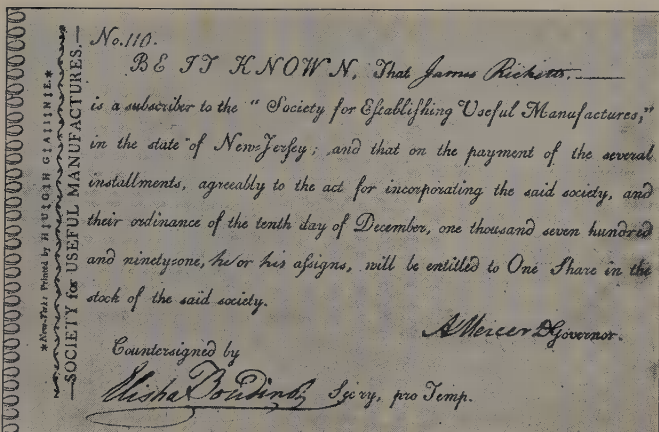
SLATER himself erected a number of mills in addition to the one at Pawtucket. The town of Webster, Mass., was founded by Slater, who in 1812 erected the first cotton mill there, seen at the left of the engraving. The home of Slater, with its four chimneys, is in the center of the engraving. Slater spent the latter part of his life in this village, and died there April 21, 1835.

THE ATTEMPT TO ESTABLISH COTTON MANUFACTURES IN NEW JERSEY

NEW ENGLAND was not permitted to keep to herself the improvements in cotton manufacture. Small mills were erected and operated in New York, New Jersey and Pennsylvania.

Notable among these projects outside of New England was the attempt to establish cotton manufacture in Paterson, N. J. Alexander Hamilton conceived a plan to make use of the water power of the Passaic River, and organized a society for that purpose.

Although a dam was built, the city of Paterson laid out and cotton mills erected, the city never became important in the cotton industry. Iron manufacture, and later the silk industry, were destined to be the source of Paterson's prosperity.



SOCIETY for USEFUL MANUFACTURES.

No. 110.

BE IT KNOWN, That James Ricketts

is a subscriber to the "Society for Establishing Useful Manufactures," in the state of New-Jersey; and that on the payment of the several installments, agreeably to the act for incorporating the said society, and their ordinance of the tenth day of December, one thousand seven hundred and ninety-one, he or his assigns, will be entitled to One Share in the stock of the said society.

A Mercer D Governor.

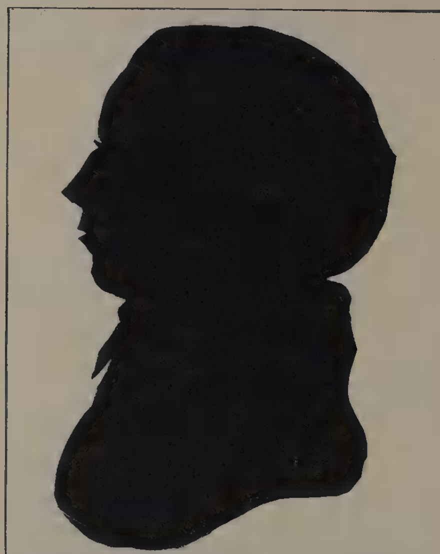
Countersigned by

Elisha Boudinot Secry, pro Temp.

87 Certificate, dated Jan. 13, 1792, issued to subscriber to the "Society for Establishing Useful Manufactures" in New Jersey, from original in the New York Public Library

INTRODUCTION OF THE POWER LOOM

SLATER'S ventures in New England and all those that imitated him were spinning mills alone. The yarn they made was still woven in the home on hand looms. The first complete cotton mill in America was the result of the foresight, persistence, and mechanical ability of Francis Cabot Lowell, a Boston merchant. It is to him that America owes the power loom. He died at the height of the attempt of British manufacturers to destroy the new factories in America by dumping goods without regard to price upon the markets of the United States.



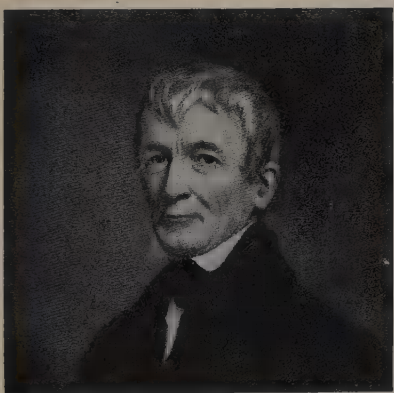
88 From a silhouette of Francis Cabot Lowell, 1775–1817, in the possession of Sidney Coolidge, Concord, Mass.

THE FIRST COMPLETE AMERICAN TEXTILE FACTORY, 1813

89 From a photograph of the painting, about 1820, location unknown, courtesy of the Boston Manufacturing Company

Lowell, traveling abroad for his health in 1811, became impressed with the importance of textile manufacture, and determined that America should have her own place in the industry. He visited the mills at Manchester, and stored his mind with all the latest improvements in machinery.

On his return in 1813, he interested his brother-in-law, Patrick Tracy Jackson, a merchant, in his scheme, and together they organized the Boston Manufacturing Company, called locally the Waltham Company, to manufacture cotton yarn and cloth. Lowell not only redevised the essential spinning machinery but, most important, reinvented in 1814 a power loom, the first in America. The Waltham Company of Waltham, Massachusetts, was the first in the world to arrange all the processes for the conversion of cotton into cloth by means of power machinery within the walls of one building. The mill is still operated as part of the property of the Boston Manufacturing Company.



90 From *Hunt's Merchants Magazine*, 1848, after an engraving by J. Cheney, of the portrait by G. P. A. Healy

PATRICK TRACY JACKSON, 1780–1847

Patrick Tracy Jackson came of a prominent Massachusetts family. His father had been a leader in colonial politics, and was a member of the Provincial Congress of 1775, and served as treasurer of Massachusetts and of Harvard University. After finishing school, young Jackson was apprenticed to a Newburyport merchant, later setting up for himself in the India trade, in which he soon amassed a fortune. He was one of the financial backers of his brother-in-law, Francis C. Lowell, in the latter's ventures at Waltham. Jackson, too, had a share in the enterprises at the city of Lowell, at Concord, New Hampshire, and other places where Boston merchants had made investments. Financial disaster overtook Jackson in the business depression of 1837.

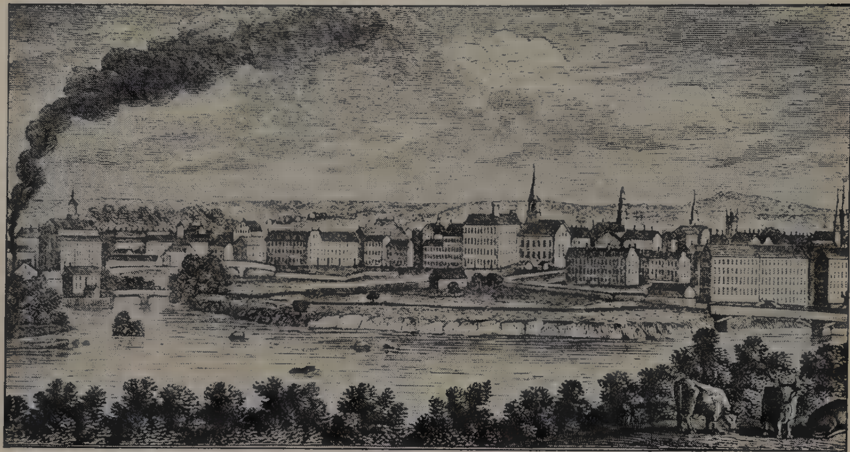
THE CITY OF LOWELL IN 1825

91 From the painting, 1825, by Benjamin Mather in the possession of the Hamilton Manufacturing Company, Boston

Outgrowing the power resources at Waltham the proprietors of the Boston Manufacturing Company employed Kirk Boott, an English trained Bostonian, to secure a better site for their enterprises. Boott purchased the property and adjacent farm lands of the Pawtucket Locks and Canals Company, which had unsuccessfully attempted to canalize the Merrimac River at Pawtucket Falls.

The Boston capitalists reorganized this company and improved its hydraulic property. They also organized the Merrimac Manufacturing Company, which secured from the Waltham Company the latter's patents. With power and machinery in their hands the capitalists set about building a cotton mill, a mill for making textile machinery, and the houses and other equipment for a town, to which the name of Lowell was given in honor of Francis Cabot Lowell, who had died before the plans were consummated.

On the left are the mills of the Merrimac Company. At the right, the large white house is the home of Kirk Boott, the manager of the Lowell mills.



92 From John Warner Barber, *Historical Collections of Massachusetts*, Worcester, 1839

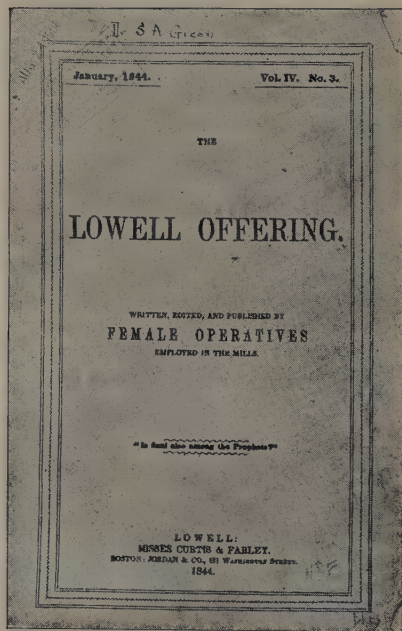
LOWELL IN 1839

The Lowell project was an immediate success. Large profits were made on the original cost of the land, and further profits were secured by the construction of mills and the sale of water privileges. The manufacture of cotton and of cotton machinery proved equally fortunate. So rapidly did the town advance that in 1836 it was made a city, and was soon in population the second city in Massachusetts. The business depression of 1837, which prostrated industry generally in the United States, was a severe blow, but eventually the town recovered and has retained to the present an important place in American manufacturing.

A PUBLICATION OF THE LOWELL FACTORY GIRLS

Samuel Slater, trained in the English mills, introduced the British system of labor into the cotton manufacturing industry in America. Naturally his example was followed, particularly in New York and New Jersey. The deplorable conditions common in the British mills were in a fair way to be transplanted to the American, without the excuse of accompanying social revolutions which somewhat mitigated the blame, even if it did not justify the actions, of the English mill operators. Fortunately, the success of Lowell with a different labor policy prevented the Slater system of labor from taking deep root in the United States.

A goodly measure of the success of Lowell was due to the labor policy of its founders. So carefully were the girls safeguarded and so rigidly were young children excluded that Lowell became the model mill town of the world. *The Lowell Offering*, a paper written, edited and published by the girls employed in the Lowell mills, is evidence of the high quality of the operatives that were attracted by the unusually favorable conditions that prevailed there.



January, 1844. Vol. IV. No. 3.

THE

LOWELL OFFERING.

WRITTEN, EDITED, AND PUBLISHED BY

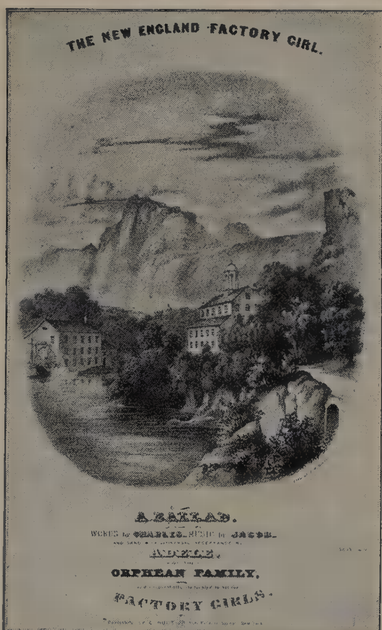
FEMALE OPERATIVES

EMPLOYED IN THE MILLS.

"Is Saul also among the Prophets?"

LOWELL:
MISSES CURTIS & FARLEY.
BOSTON: JORDAN & CO., 121 WASHINGTON STREET.
1844.

93 Title-page of the issue of Jan. 1844



94 Title-page of the original, 1848, in the possession of the publishers

A PÆAN TO THE FACTORY GIRL

The American factory girl in the early days at Lowell belonged to the same type that now fills the ranks of the school teachers or stenographers. Most of the girls came from old American stock, and many of them in time became the wives of community leaders and the mothers of men and women who now stand at the forefront of American affairs. The ballad of the *New England Factory Girl* was widely popular in the middle of the last century.

95 From *Gleason's Pictorial*, May 29, 1852

PARK OF THE BOOTT COTTON MILLS, LOWELL

Among the newer factories immediately following the Merrimac Company were the Hamilton Manufacturing Company, organized in 1825 and the Boott Mills in 1835. The latter illustrated the labor policy of Lowell, for the mills were erected around a park designed for the recreation and pleasure of the mill "help."

MANUFACTURING VILLAGES, NINETEENTH CENTURY

Following the successes at Pawtucket, Waltham and Lowell, dozens of other places with water power at command inaugurated textile manufacture. Factories were built after the familiar models of the time. Labor was drawn from the surrounding country districts or perhaps from the village itself. The traveler among these factory towns found them strikingly similar in appearance. A view of one might easily be taken for another.

96 Cotton Factory Village, Glastonbury, Conn., from John Warner Barber, *Connecticut Historical Collections*, New Haven, 1836

97 Southeast View of Mills Village, Salisbury, Mass., from John Warner Barber, *Historical Collections of Massachusetts*, Worcester, 1839

CHAPTER IV

HARNESSING THE FORCES OF NATURE

MANKIND has always endeavored to mitigate the injunction that man should live by the sweat of his brow. One of the marks of progress is man's continual release from the most arduous toil by bending other forces to accomplish this work. Human muscle, the first source of power, was only relieved and augmented when men turned to the muscles of beasts. But the muscle power of any animal, man included, is a puny thing compared to the gigantic forces in nature. Winds, tides, falling water, are all manifestations of power. It has been man's task to harness these forces so as to supersede and multiply the power of muscle, freeing men from the most difficult work, and gaining results impossible from muscle alone.

Centuries ago the wind was harnessed. Men spread sails on ships and compelled the air current to do their work. This utilization of natural energy finally made possible the discovery of America. It was the sailing ship which enabled European nations to establish colonies on the new continent. But sailing ships were not adapted to upstream traffic on American rivers. The wind brought European civilization to the edge of North America but could not carry it into the interior.

After taking advantage of the wind, men utilized the power of falling water. Much of the early factory development in both England and America was dependent upon the power supplied by the water wheel. This energy ran the machines which marked the beginning of the end of the age of handicrafts. In hilly New England are many streams whose courses have frequent falls and rapids. The same is true of the Middle Atlantic states. Farther south a widening coastal plain makes impossible the development of water power near the shore. On the New England streams occurred the first important utilization of natural power in America.

Water power was one of several factors that contributed to make New England the locality in which the factory system got its start in the United States. The soil is inferior on many of the stony hillsides of Connecticut, Rhode Island and Massachusetts. In the opening decades of the nineteenth century, when the factory system was appearing in America, much of this land had been tilled for more than a century and a half and was showing unmistakable signs of deterioration. Some farmers were moving away in that expansion of New England which carried its people west into New York state and the Ohio valley. Others welcomed the new factory as a place where their children and their grown-up daughters might aid materially in swelling the family income. New England possessed water power ample for the needs of the early factories and had besides a supply of labor of the highest skill.

But New England claimed one further advantage. There since early times had flourished the sea trade. The streets of such coast towns as New Haven, Providence, and Boston were dotted with the homes of sea captains. These sea captains and the merchants with whom they were associated made the first important accumulations of fluid capital that the United States had seen. During the troubled years from Jefferson's Embargo of 1807 to the close of the War of 1812, much of this capital was driven out of the trading enterprises where it had long been invested. Under the circumstances it was set to work building and running factories intended to supply the American market.

MAN'S EARLIEST POWER AIDS

98 From an exhibit in the United States National Museum

THE earliest power aids used by men were the lever, the inclined plane and the roller. The picture shows all three of these in use at once, but each was an individual application of power and each has had its own historical development. The lever is perhaps the oldest. By means of a pole balanced over a block, a man's weight could move or raise what his muscle alone could not budge. By means of the inclined plane, great weights could be moved to heights or depths impossible of attainment otherwise. The roller was a round log which reduced labor by removing some of the friction occasioned in moving a weight. These three devices were known to men at the dawn of history and adaptations of them are essential features of many modern mechanical contrivances.

A WINDLASS FOR LOWERING AND RAISING WEIGHTS

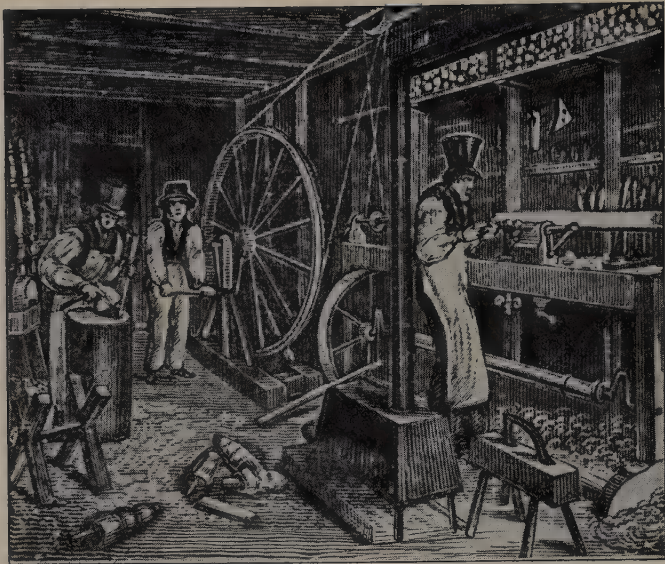
THE windlass (No. 99) is nearly as ancient as the lever, inclined plane and roller. The windlass enables a small expenditure of effort to hold, lower, raise or move great weights. Perhaps the idea originated in passing a rope around a tree so that a single man could snub and control a plunging animal. Substitute a roller for the tree and a weight for the animal and the essentials of the windlass appear. With the aid of a crude windlass a pony can move a great house, or a small group of men can warp a ship. The ancient windlass still plays an important rôle in the modern age of the highly developed machine.

99 From Georg Agricola, *De re metallica*, Basle, 1556

A TREADMILL FOR PUMPING WATER FROM A MINE

100 From Georg Agricola, *De re metallica*, Basle, 1556

THE treadmill (No. 100) was an adaptation and amplification of the turn-post idea. Power was produced by men continuously climbing steps attached to a wheel or cylinder. The treadmill has long served as a symbol of endless and fruitless effort. Yet in its day the treadmill furnished power useful for many purposes where other sources of power were unknown or unavailable.



101 The Turner, from Edward Hazen, *Popular Technology*, etc., New York, 1843

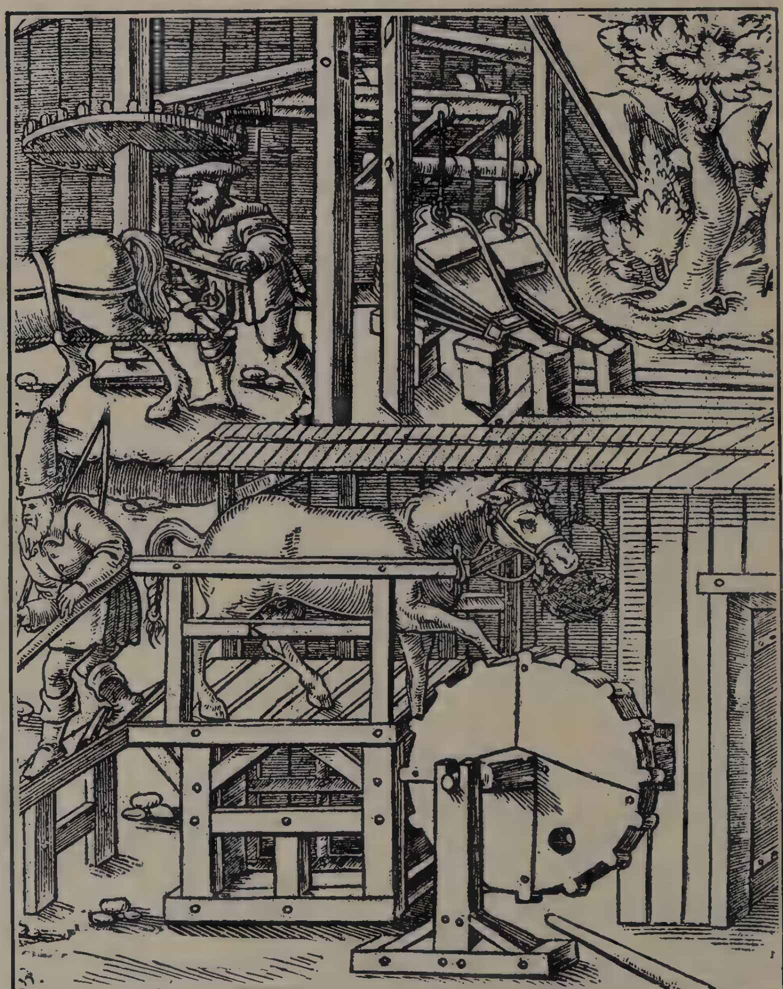
A CRAFTSMAN'S SHOP OPERATED BY HAND POWER

An advance beyond the treadmill and the turn post was the transfer of the motion of a wheel to a shaft by means of a rope or belt. In the turner's shop the block of wood was fastened at the ends and then whirled round against the edged tools of the artisan who thus gave them the desired shape. Two familiar devices aided in this work. From a wheel operated by a hand crank a rope or belt carried the motion to an overhead movable shaft. From the shaft another rope or belt conveyed the motion to the object on which the turner worked. Under the bench may be seen a wheel moved by a foot treadle. The wheel in turn moved a shaft from which the motion was carried by ropes or belts upward to an object on the bench.

THE UTILIZATION OF ANIMAL POWER

The turnpost and the treadmill were early adapted to operation by horse power. The picture shows a sixteenth-century scene, but the machinery of Slater's first American cotton mill was for a time set in motion by a man and later by a horse attached to a turning post. Likewise at Southbridge, Mass., the diminutive shop that has since grown to be the American Optical Company was at times in its first years furnished with power by a lusty negro tied to a turning post, who was later relieved by a horse. These are by no means isolated examples in comparatively recent times.

The treadmill was destined to have a long and honorable history in the development of American machinery. It was tried as a motive power for boats and railroads. In the early nineteenth century its use became widespread among the farmers as a source of power for threshing grain.



102 From Georg Agricola, *De re metallica*, Basle, 1556

HARNESSING THE WIND

Among the first machines used in America for the production of mechanical power was the windmill. The huge vanes covered with sailcloth revolved in the wind. The whole top of the building could be moved as the wind shifted, by means of a long spar attached to a cart wheel. To move the spar the miller had to augment his strength with a small capstan and tackle.

103 Windmill at Newport, Rhode Island, from an engraving, after a drawing by G. Wall, published in London, 1831

104 Redrawn from a photograph. © H. S. Wyer, Nantucket

THE NANTUCKET WINDMILL

The Nantucket mill (No. 104), built in 1746 and still in existence, was a target for a British man-of-war during the Revolution, and by 1828 was in such disrepair that it was sold for firewood for the sum of twenty dollars. But the new owner, discovering that its solid oak frame was in good condition, restored the entire structure and again set the mill to grinding grain.

INTERIOR WHEEL AND SHAFT, NANTUCKET MILL

Inside the revolving top of the Nantucket windmill (No. 105), on the same horizontal shaft to which the vanes were attached, was a heavy wooden wheel (A) with pegs on its face. These pegs engaged with the lattice drum (B) around the main shaft (D). The shaft led down through the floor and conveyed the motion of the vanes to the millstones below.

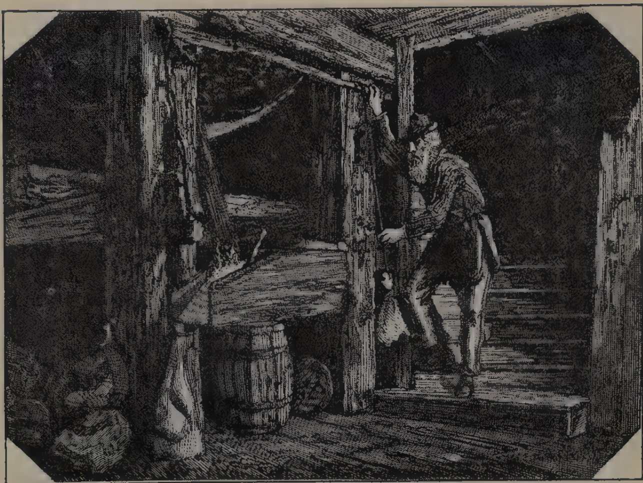
Around the heavy wheel of the vane shaft was a wooden strap (C) which could be tightened to brake the movement of the vanes, or, in the case of a gale or emergency repairs, to halt it altogether. This strap looked and acted much like the modern brake bands on the wheels of automobiles.

105 From *Harper's Weekly*, Aug. 16, 1879, after a drawing by Wendell Macy

106 From *Harper's Weekly*, Aug. 16, 1879, after a drawing by Wendell Macy

HOPPER OF THE NANTUCKET MILL

On the floor below (No. 106), the shaft (D) turned through the central portion of the hopper. The hopper was merely a device for feeding the grain to the millstones. The grain was poured into the hopper and from it was led by a spout to the millstones on the floor below.



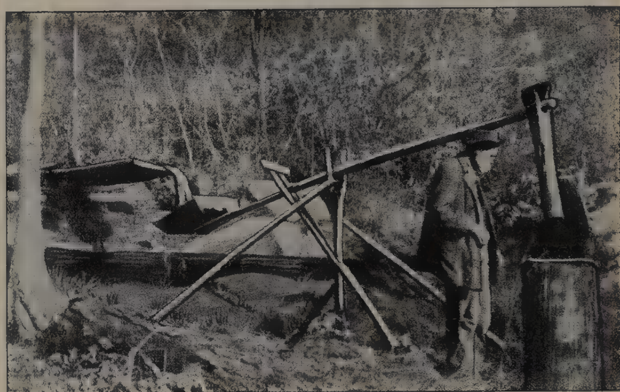
107 From *Harper's Weekly*, Aug. 16, 1879, after a drawing by Wendell Macy

GRINDING THE GRAIN AT THE WINDMILL

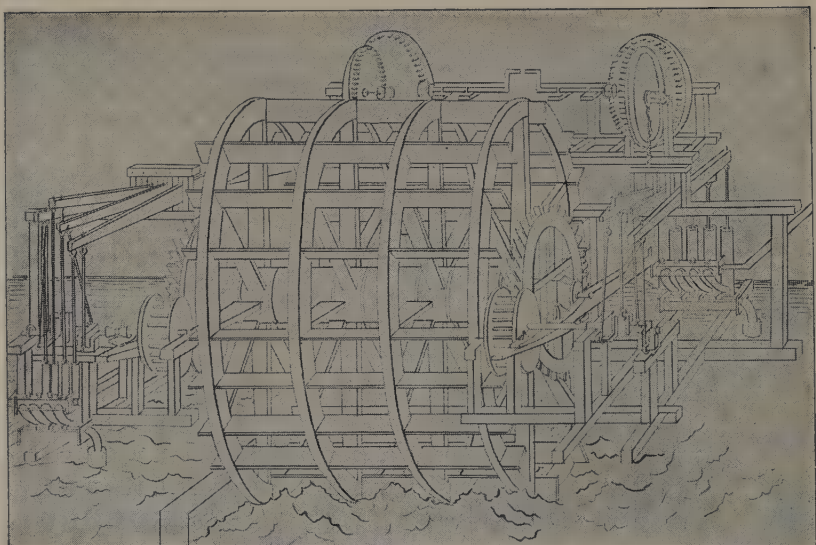
ON the first or lowest floor were the millstones. The miller with one hand on the lever regulated the position of the upper millstone and thereby determined the coarseness or fineness of the meal he produced. To the left is the spout for feeding the finished meal into bags or barrels.

A PRIMITIVE "POUNDING MILL"

WATER power was also early put to work to relieve men's muscles and add to muscular productivity. One of these primitive uses of water power was a "pounding mill," a mechanical adaptation of the mortar and pestle for grinding grain. A pole was supported across a notched stick and was made to move in a single plane by a simple device. At one end of the pole was a weighted mallet which, descending into a hollowed log, cracked and ground the grain. At the other end of the pole was a tight box into which water flowed until its weight raised the mallet. As soon as the pole moved downward under the burden of the water-filled box the latter tipped and spilled the contents, which caused the mallet to thud downward into the log and do its work upon the grain. With a slow rhythm the corn in the crude mortar was ground into meal. This crude device, the result of the ingenuity of a backwoodsman who lived apparently far from a mill, illustrates an important characteristic of early Americans. They were an inventive people and, in the first half of the nineteenth century, the term, "Yankee inventiveness," resulted from the wide variety of contrivances which they developed.



108 From *Tennessee, the Volunteer State, 1769–1922*, courtesy of the S. J. Clarke Publishing Co.



109 From William Matthews, *Hydraulia*, London, 1835

A FAMOUS ENGLISH FLOAT WHEEL

ONE of the most famous experiments with water as a source of power was the set of wheels built at London Bridge. The wheels were crude paddles that dipped into the current of the Thames River. The force of the current striking against the paddles caused the wheels to revolve. This sort of power producer was known as a float wheel. The power here made available was employed in pumping water from the Thames River.

OLD FLOAT WHEEL AT SPRINGFIELD, LONG ISLAND

THE float wheel eventually was arranged to turn a shaft in grist, saw or fulling mills. It was the simplest form of water-power utilization because it required no expensive building of dams or other devices in connection with conducting the water to the wheel. The force of the natural current alone did the work.

110 From *The Art Journal*, New York, 1876, after the painting by Charles Henry Miller (1842–1922)

111 From *The American Pioneer*, Chillicothe, Ohio, March, 1843

FLOAT WHEEL AT THE FIRST GRISTMILL AND SAW-MILL IN OHIO, 1789

THE grist and sawmill at Wolf Creek, the first in Ohio, was supplied with power by an adapted float wheel. Its wrought-iron crank, weighing a hundred and eighty pounds, made in New Haven, Connecticut, had to be carried over the Alleghenies on a pack horse to the Youghiogheny River and thence by boat to Marietta on the Ohio. In the face of such difficulties it is no wonder that crude power devices were the rule when white men first settled new American territories.

112 From *The Art Journal*, New York, 1879, after the painting by Jasper F. Cropsey (1832–1900)

AN OLD MILL WITH OVERSHOT WHEEL

IN a more efficient type of wheel the water is directed overhead and by its own weight as it falls turns the wheel round. This is known as the overshot wheel. In order to get the necessary force and height of water, dams were placed across the stream.

OVERSHOT WHEEL AT THE WINTHROP MILL, NEW LONDON

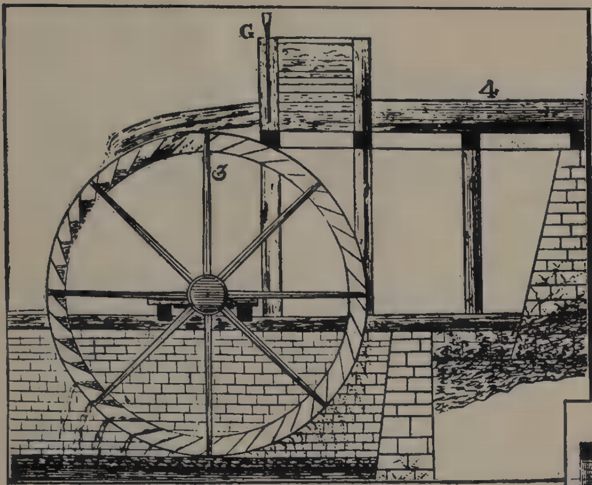
An overshot water wheel calls for certain subsidiary equipment. The water must be gathered behind a dam above the mill and led on to the wheel by a wooden trough or pipe known as the "flume" or "penstock." The water pouring down from the flume upon the vanes of the wheel causes them to revolve. The old town mill at New London was built in 1690 by Governor John Winthrop. It still grinds grain into flour.

113 © Halliday Historic Photograph Co.

TIDAL MILL AT STROUDWATER, MAINE

In low regions along the coast where streams had insufficient drop for water power, men sometimes utilized the difference in the height of tidal basins or streams at high and low tide. At high tide the water was impounded behind a dam and upon being released at low tide gave the effect of a waterfall. The economic deficiency in this form of water-power utilization was the intermittency in the power possibility and the continuous change in the height of the fall. Hence tidal mills have never been much of a factor in production. This picture was taken at low tide. The wheel cannot be seen from this angle.

114 © Halliday Historic Photograph Co.



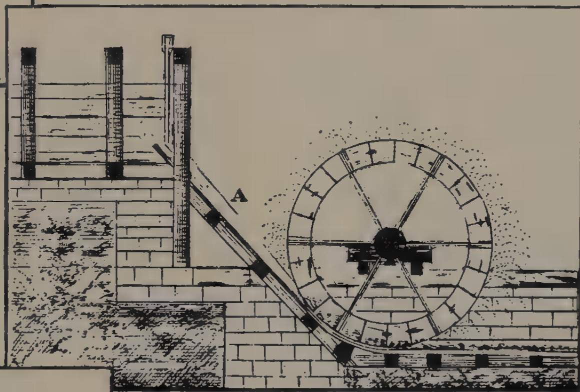
115 From Oliver Evans, *The Young Mill-Wright and Miller's Guide*, Philadelphia, 1795

THE OVERSHOT WHEEL OF OLIVER EVANS' DAY

BETWEEN the float wheel and the overshot wheel were many types familiar to our forefathers. Oliver Evans, one of the famous engineers and inventors of the early Republic, in *The Young Mill-Wright and Miller's Guide*, gives illustrations of the types of wheels common at the end of the eighteenth century. In the overshot wheel (No. 115) the water was led on to the wheel (3) through the penstock (4). The gate (G) kept back the water until needed.

UNDERSHOT WHEELS

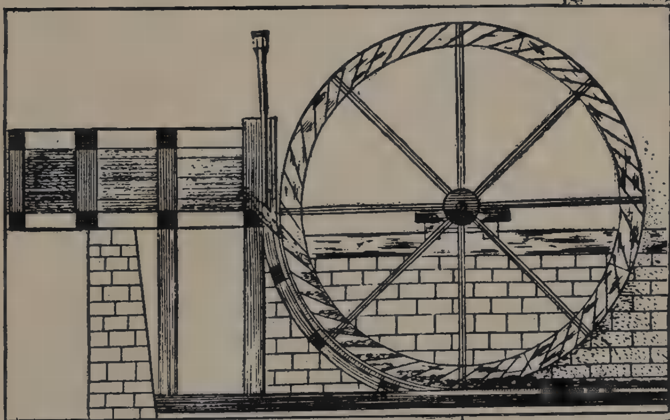
IN the undershot wheel a narrow swift stream of water was shot through a flume or penstock (A) directly on to the wheel blades from below. The speed of the water and the force of its impact, rather than the weight of the water, are the motive forces.



116 From Oliver Evans, *The Young Mill-Wright*, etc., 1795

THE BREAST WHEEL

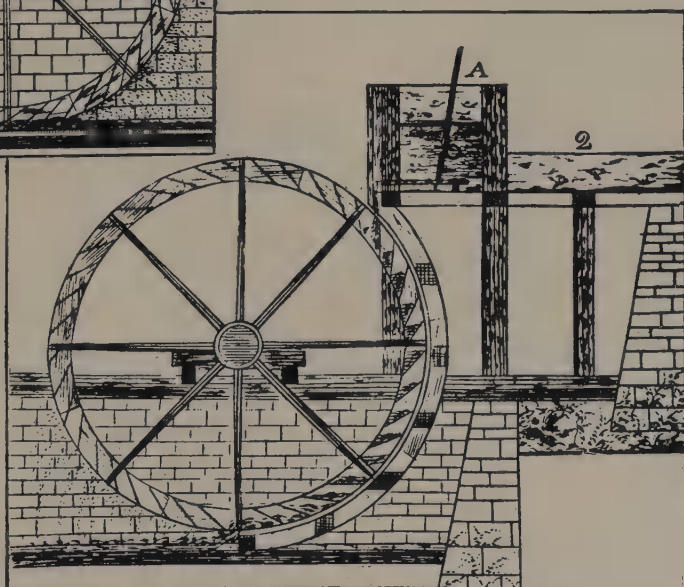
THE breast wheel was a hybrid combining the essentials of both the undershot and overshot wheels. In this type of wheel the water struck the vanes about halfway up.



117 From Oliver Evans, *The Young Mill-Wright*, etc., 1795

THE PITCH BACK WHEEL

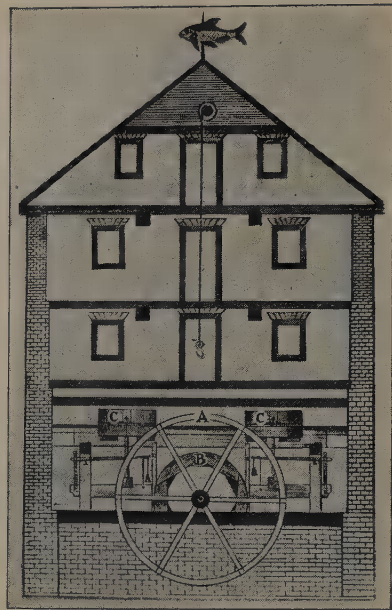
THE familiar direction of the action of a water wheel was toward the right. In a pitch back wheel arranged like a high breast wheel this motion was reversed, hence the name. The water coming through the penstock (2) is held in check by the gate (A) until needed to turn the wheel. Oliver Evans, from whose practical book the cuts are taken, was an inventor of a number of successful machines used in flour and other mills.



118 From Oliver Evans, *The Young Mill-Wright*, etc., 1795

OUTSIDE VIEW OF A MILLHOUSE

Evans' book contains instructions for the erection of millhouses. In the illustration part of the wall of the mill has been removed to show the operation of the mill machinery. (A) is the big outside water wheel which furnished the power; (B) the cogwheel within the mill to which the power was transferred; and (C) the millstones which did the grinding. In such mills were ground the grists of the colonial and early nineteenth-century farmers. Some have persisted even to the present.

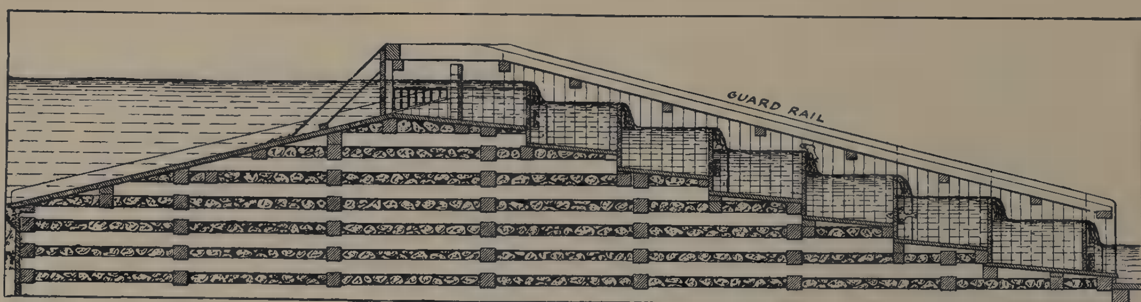


119 Simplified from Oliver Evans, *The Young Mill-Wright*, etc., 1795

120 From a photograph by the United States Forest Service

OLD-TIME DAM AND LOGWAY, MINNESOTA

All water wheels except the float wheel required the construction of a dam across the stream. These dams interfered with two other interests, the logging and fishing industries. Consequently the owners of milldams in logging territory were required to provide means for getting logs beyond the dam without permitting them to fall over the crest. The illustration shows one of the familiar constructions by which both the mill and the logging interests were conserved. The logway is in the foreground. The dam itself is a crude one made of logs, loose stones, and earth.



121 Courtesy of the United States Bureau of Fisheries

THE FISHWAY

The necessity for providing passage for fish where milldams obstructed streams arose from the fact that many species of fish seek the headwaters of streams for breeding purposes. Although some species are able to leap and swim upstream against rapids and minor falls, they were checked by the dams. Hence the builders of dams were forced to construct gates which were opened for the passage upstream of adult fish, and for the journey down of the young. Sometimes, too, at one side of the dam the height was broken into a series of smaller dams arranged like steps. These, called "fish ladders," enabled the fish to surmount or descend the dam with ease and safety.

122 © Eastern Illustrating Co.

THE DAM AT SEYMOUR, CONNECTICUT

When men first began building dams they were limited by their knowledge and resources to small streams. Most of the dams were made of earth, or combinations of stone and earth, or stone, earth and logs. Later they improved natural waterfalls by extending them with rock dams, the rocks being held in place with lime mortar. The Seymour dam in the Naugatuck River was of the latter variety when first built shortly after the opening of the nineteenth century. It was constructed by David Humphreys to run one of the earliest merino wool factories in America. For over a century and a quarter there has been some sort of a wool mill operating at this site and using the water power made available by the dam. In times of "high water" the flood pours over the natural rocks at the left.

123 From a photograph, courtesy of Arthur T. Safford, Lowell, Mass.

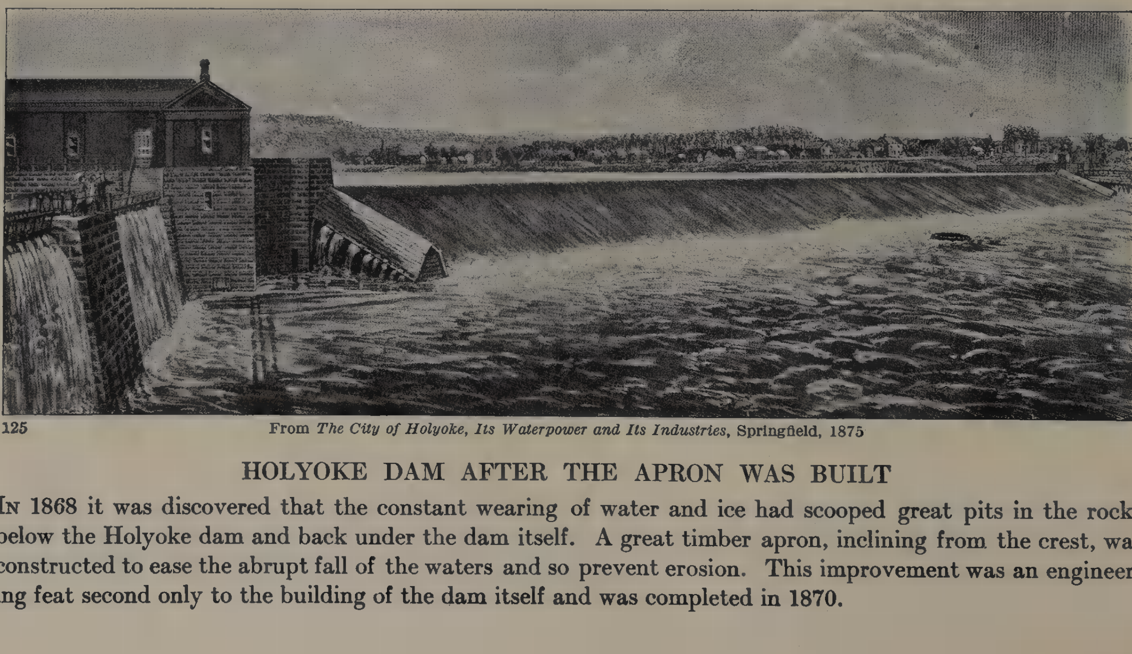
DAM OVER THE MERRIMAC AT LOWELL

The cotton manufacturing venture at Lowell, Mass., beginning in 1823, marks the inauguration of man's attempt to utilize the power possibilities of larger streams. The Merrimac River at this point has nearly thirty feet of fall and a stone dam was built across the river to make this drop produce power.

124 From *Harper's Weekly*, Jan. 31, 1869, after a photograph taken during a flood

THE HOLYOKE DAM, BUILT 1849

The largest water-power project in New England is at the city of Holyoke, Mass., on the Connecticut River. The size and volume of the river at this point, together with a difference in level of sixty feet above and below the city, account for the large amount of power available at this point. The first venture was made in 1831 when a wing dam was projected a short way from the shore into the current, which diverted a small volume of water to the wheel of a small mill. A more ambitious enterprise was inaugurated in 1847. The stream was measured, a company organized and a great timber dam, iron capped, built across the river. This dam was thirty feet high and about a fifth of a mile long. Two hours after the gates were first shut the dam broke under the enormous pressure of the stream. The lesson learned, a stronger timber dam was built and finished in 1849. For a generation this dam was the central feature in the largest and most daring water-power project in America.



125 From *The City of Holyoke, Its Waterpower and Its Industries*, Springfield, 1875

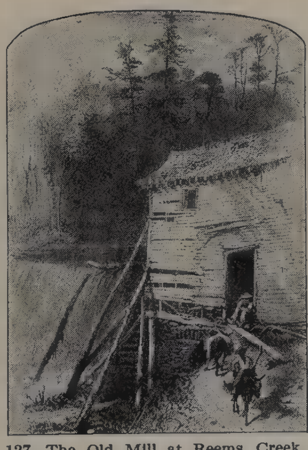
HOLYOKE DAM AFTER THE APRON WAS BUILT

In 1868 it was discovered that the constant wearing of water and ice had scooped great pits in the rocks below the Holyoke dam and back under the dam itself. A great timber apron, inclining from the crest, was constructed to ease the abrupt fall of the waters and so prevent erosion. This improvement was an engineering feat second only to the building of the dam itself and was completed in 1870.

126 From a photograph, courtesy of W. C. Livermore, Springfield, Mass.

WATER POURING OVER HOLYOKE DAM, 1913

THE third improvement of the Holyoke dam was made in 1900 when the old timber, iron-sheathed dam was abandoned and a new dam constructed of solid granite. The new dam had a curved front to carry out the purpose of the apron on the old dam. Although this dam still creates the largest water power in New England, the Holyoke project is no longer the greatest water-power enterprise in America, a record it long held. Niagara, McCall's Ferry, Keokuk, and Muscle Shoals are among the modern projects that have dimmed the glory of Holyoke, to say nothing of great irrigation power dams such as the Roosevelt Dam of the Salt River irrigation of Arizona.



127 The Old Mill at Reems Creek, North Carolina, from *Picturesque America*, New York, 1872, after a drawing by Harry Fenn

CHAPTER V

KING COAL

MORE important than winds and water for the production of power and of heat has been coal. Mining of all kinds, mechanical transportation, manufacturing and domestic heating all depend upon coal. Coal is the most valuable mineral in the world. What the world calls coal is the soft or bituminous variety. Of this the fields in the United States are remarkable only for their vast extent. Many other parts of the world have large deposits of soft coal; industrial leadership everywhere depends upon bituminous coal, and the struggle for coal plays a large part in modern history.

But of one variety of coal the United States possesses a monopoly. That is anthracite or hard coal, and this is found in commercial quantities and of commercial quality only in eastern Pennsylvania. The discovery of anthracite and its utilization form the unique contribution of America to the history of coal. The Indians of Pennsylvania were familiar with the black ledges outcropping along the forested slopes of the hills, but since coal meant nothing to them, its presence was ignored. So too the first white settlers who penetrated the region interested themselves in the conventional pursuit of agriculture, quite ignorant of the fact that underneath the farms of many of them lay one of the world's richest mineral storehouses. The utilization of coal waited upon industrial development, particularly the development of the steam engine. When industrial magnates began to chafe at the limitations imposed by water power in the days before hydroelectricity they turned to the serious study of the practical utilization of coal.

One of the curious aspects of American development followed from the fact that the American anthracite fields lie east of the bituminous fields with the result that the westward moving frontier came upon anthracite first. Moreover anthracite was nearer to the population centers of the coast, Baltimore, Philadelphia and New York. The result was that anthracite was the first American coal to come in quantity on the market, and much time and experimentation were required before it could be efficiently used. The methods of mining and utilization of bituminous coal were introduced from England, but anthracite presented problems which Americans had to solve unaided. With the development of the coal industry, the day of the old water wheel passed.

The primitive application of water power had many limitations. Insufficient engineering skill denied control of the larger streams; earth fills, log and loose stone dams were necessarily confined to the smaller waterways. The narrowness of the valleys in which dams could be constructed prevented the expansion of manufacturing plants. Most important of all was the impossibility of increasing the amount of water power available at any given point. To offset this handicap much attention was given to improvements in water-power mechanics and devices in an effort to turn every bit of potential power into usable energy.

When at length water power had proved itself incapable of meeting the demands of the rapidly expanding industries of the country, favor turned to the steam engine. The constant improvement of this machine more than kept pace with industry. The ability to place a steam engine anywhere and to multiply its units gave obvious advantages over water power. Coal, natural gas and other petroleum products were the fuel for the new source of power.

THE ORIGIN OF COAL

128 Fossil Fern from a West Virginia Coal Mine, from a photograph by the United States Geological Survey

MILLIONS of years have passed since that area in the United States which is now Pennsylvania, Indiana and Illinois was a swampy country lying close to sea level. Neither the majestic Rockies nor the Appalachians had been piled up by deformations of the earth's crust. Where the latter stand to-day the land in this ancient Carboniferous Age was relatively level and covered with forests of strange trees. The climate was warm; the forests and undergrowth were of a tropical luxuriance. But everywhere was silence, save for the sounds of inanimate nature. No mammals or reptiles ran over the ground or climbed in the branches. No birds flitted from limb to limb. Life in its development had not yet produced such forms. Vegetation covered the hills and the plains, here with a carpet of ferns and there with a jungle of trees. Then the Carboniferous Age came to an end. During its latter stages the land tended more and more to sink below the sea. Its forests and swamps were converted into gigantic peat bogs and, finally, in the age that succeeded, these were buried beneath thick layers of strata. Heat and pressure below the surface of the earth transformed the peat into coal.

129 The Age of Coal Accumulation; restoration by Unger, courtesy of the United States National Museum

130 From an exhibit in the United States National Museum

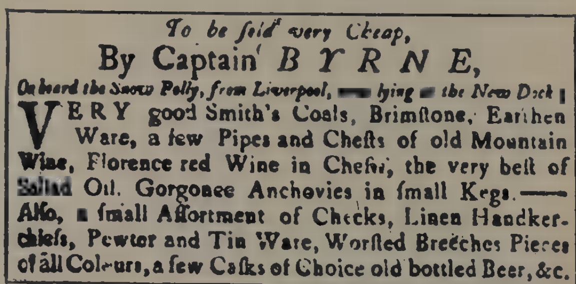
VARIETIES OF COAL FORMATION

The successive chemical changes in the evolution of coal from living vegetation to anthracite may be indicated best by models. Living plants contain carbon, moisture, sulphur, various hydrocarbons, and non combustible mineral matter. In the formation of coal vast beds of plants were covered with water or earth with the result that decay was checked. Geologic action produced heat or pressure or both. The varying degrees of heat or pressure forced out in different proportions the moisture, hydrocarbons (in the form of gases) and sulphur. As a consequence the original carbon occupied a greater proportion of a given amount of material. Since carbon is the material that gives heating value the fuels are ranged in accordance with their proportionate volume of carbon, peat having the least and anthracite the most. Beyond anthracite come graphite and diamond in which the proportion of carbon is too great to burn except at high temperatures. Since the hydrocarbons help ignite the carbon and themselves have some heating value the most valuable coals are certain varieties of super-bituminous or semi-anthracite and not anthracite itself. The dark substance in the models represents carbon, increasing in relative proportion from turf to graphite.

131 From L. Hennepin, *New Discovery*, etc., London, 1698

AN EARLY MENTION OF COAL IN AMERICA

The existence of coal in America was known at an early date. In 1673 Joliet and Marquette noted coal in their travels in the Mississippi valley, and a few years later that indefatigable explorer, Father Hennepin, published a map showing a "cole mine" along the Illinois River, a little way above Fort Crèvecœur.



To be sold very Cheap,
By Captain B Y R N E,
On board the Snow Polly, from Liverpool, now lying at the New Dock;
VERY good Smith's Coals, Brimstone, Earthen Ware, a few Pipes and Chests of old Mountain Wine, Florence red Wine in Chests, the very best of Sallad Oil. Gorgonee Anchovies in small Kegs.——Also, a small Assortment of Checks, Linen Handkerchiefs, Pewter and Tin Ware, Worsted Breeches Pieces of all Colours, a few Casks of Choice old bottled Beer, &c.

132 From the *New York Gazette, or Weekly Post-Boy*, June 20, 1765

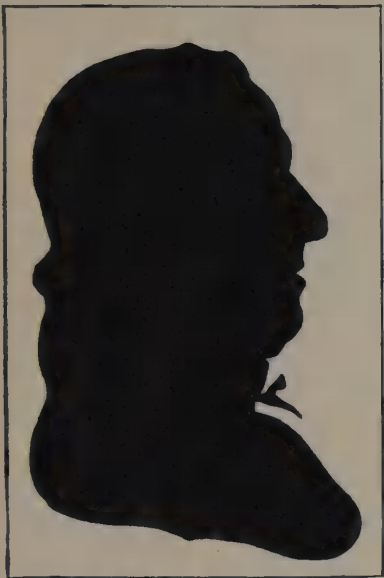
ENGLISH COAL "VERY CHEAP," 1765

Although coal was known at an early date no attempt was made to mine it until 1750, when a small bituminous mine was opened near Richmond, Virginia. For years this was the only important American source for coal and "Richmond Coal" became a byword. It was used principally by blacksmiths. Most of the coal consumed during the colonial period came from England. Advertisements by shipmasters from Liverpool such as this one of Captain Byrne were frequent in the colonial newspapers. There was no great demand for coal, for the smiths were the main users. They needed a hot and flameless fire in which to heat their iron before shaping it on the anvil. The local ironmasters who refined the iron ore taken from bogs used charcoal in their furnaces.

OBADIAH GORE, 1744–1821, AN EARLY USER OF ANTHRACITE

THE first knowledge of anthracite seems to have been acquired in Rhode Island in 1760. Two years later a similar discovery was made by a company of Connecticut pioneers who had settled in the Wyoming Valley of Pennsylvania. The first practical use of anthracite as a fuel was probably made by one of these pioneers, Obadiah Gore, a blacksmith, who in 1769 burned anthracite in his forge. Following this demonstration anthracite came into general use among the blacksmiths of the neighborhood.

133 From a crayon portrait in the Wyoming Historical and Geological Society, Wilkes-Barre, Pa., after a painting in the possession of the Gore family



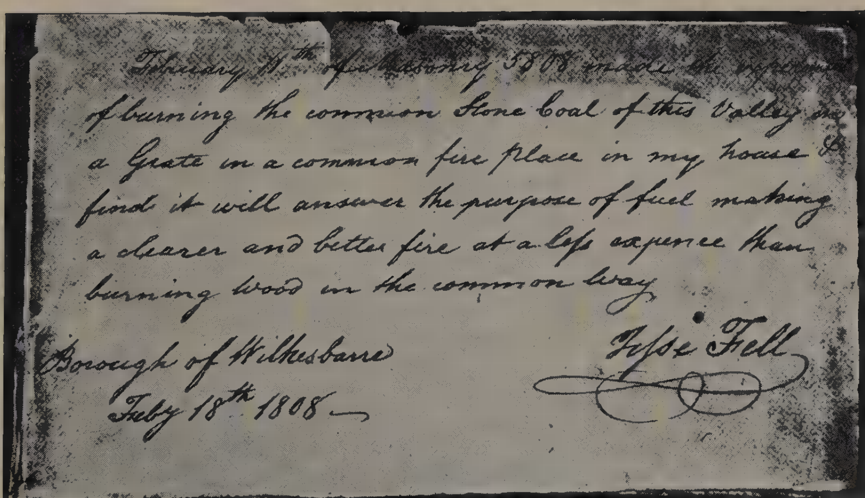
134 Judge Jesse Fell, 1751–1830, from a silhouette in the possession of Ernest G. Shaw, Wilkes-Barre, Pa.

EXPERIMENTS WITH ANTHRACITE

THE value of anthracite became known but slowly. For many years it was used only by a few blacksmiths in their forges. Experiments with anthracite as a general heating fuel were nevertheless going on. In 1802 Frederick Graff burned anthracite in a large stove in Philadelphia. In 1803 Oliver Evans burned the fuel in a grate and in 1808 Judge Jesse Fell of Wilkes-Barre did likewise. The ignorance of the times concerning this fuel is well illustrated by the fact that Fell knew nothing of Evans' previous experiments. Wood was plentiful, and the heating devices of the early nineteenth century were adapted to its use. Many years elapsed, even though the experiment of Judge Fell became fairly well known, before any large number of Americans came to use this stony fuel. For another two generations the coal seams that had originated in the ancient Carboniferous Age remained relatively undisturbed.

JUDGE FELL RECORDS HIS EXPERIMENT

THE success of his experiment in burning anthracite was recorded by Judge Fell upon the flyleaf of a book in his library. The record is still in existence. It reads as follows: "February 11th of Masonry 5808 made the experiment of burning the common Stone Coal of this Valley in a Grate in a common fireplace in my house. I find it will answer the purpose of fuel making a clearer and better fire at a less expense than burning wood in the common way." These early haphazard experiments are characteristic of an age unfamiliar with the scientific method and untrained in systematic research. Yet from them came a rough knowledge of the nature and use of the hard coal that became known as anthracite.

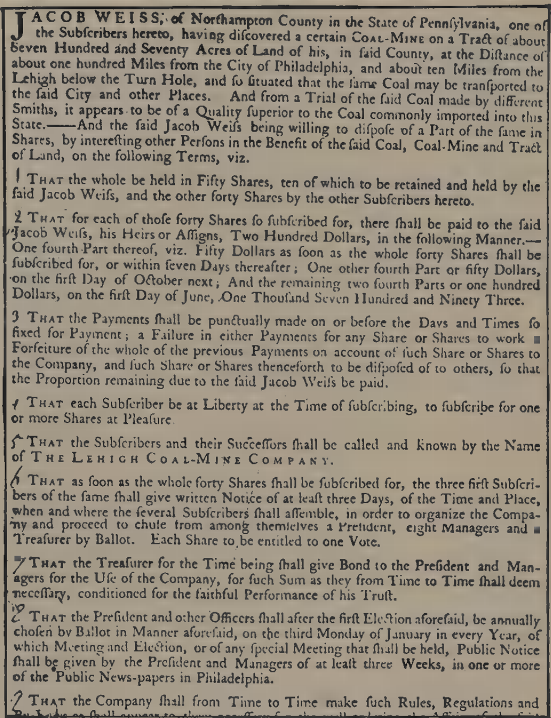


February 11th of Masonry 5808 made the experiment of burning the common Stone Coal of this Valley in a Grate in a common fire place in my house & find it will answer the purpose of fuel making a clearer and better fire at a less expence than burning wood in the common way.

Borough of Wilkesbarre
Feby 18th 1808 —

Jesse Fell

135 From the flyleaf of Fell's copy of *Illustrations of Masonry*, in the Wyoming Historical and Geological Society



JACOB WEISS, of Northampton County in the State of Pennſylvania, one of the Subſcribers hereto, having diſcovered a certain COAL-MINE on a Tract of about Seven Hundred and Seventy Acres of Land of his, in ſaid County, at the Diſtance of about one hundred Miles from the City of Philadelphia, and about ten Miles from the Lehigh below the Turn Hole, and ſo ſituated that the ſame Coal may be tranſported to the ſaid City and other Places. And from a Trial of the ſaid Coal made by different Smiths, it appears to be of a Quality ſuperior to the Coal commonly imported into this State.——And the ſaid Jacob Weiſs being willing to diſpoſe of a Part of the ſame in Shares, by intereſting other Perſons in the Benefit of the ſaid Coal, Coal-Mine and Tract of Land, on the following Terms, viz.

1 THAT the whole be held in Fifty Shares, ten of which to be retained and held by the ſaid Jacob Weiſs, and the other forty Shares by the other Subſcribers hereto.

2 THAT for each of thoſe forty Shares ſo ſubſcribed for, there ſhall be paid to the ſaid Jacob Weiſs, his Heirs or Aſſigns, Two Hundred Dollars, in the following Manner.—One fourth Part thereof, viz. Fifty Dollars as ſoon as the whole forty Shares ſhall be ſubſcribed for, or within ſeven Days thereafter; One other fourth Part or fifty Dollars, on the firſt Day of October next; And the remaining two fourth Parts or one hundred Dollars, on the firſt Day of June, One Thouſand Seven Hundred and Ninety Three.

3 THAT the Payments ſhall be punctually made on or before the Days and Times ſo fixed for Payment; a Failure in either Payments for any Share or Shares to work a Forfeiture of the whole of the previous Payments on account of ſuch Share or Shares to the Company, and ſuch Share or Shares thenceforth to be diſpoſed of to others, ſo that the Proportion remaining due to the ſaid Jacob Weiſs be paid.

4 THAT each Subſcriber be at Liberty at the Time of ſubſcribing, to ſubſcribe for one or more Shares at Pleaſure.

5 THAT the Subſcribers and their Succeſſors ſhall be called and known by the Name of THE LEHIGH COAL-MINE COMPANY.

6 THAT as ſoon as the whole forty Shares ſhall be ſubſcribed for, the three firſt Subſcribers of the ſame ſhall give written Notice of at leaſt three Days, of the Time and Place, when and where the ſeveral Subſcribers ſhall aſſemble, in order to organize the Company and proceed to chuſe from among themſelves a Preſident, eight Managers and a Treaſurer by Ballot. Each Share to be entitled to one Vote.

7 THAT the Treaſurer for the Time being ſhall give Bond to the Preſident and Managers for the Uſe of the Company, for ſuch Sum as they from Time to Time ſhall deem neceſſary, conditioned for the faithful Performance of his Truſt.

8 THAT the Preſident and other Officers ſhall after the firſt Election aforeſaid, be annually choſen by Ballot in Manner aforeſaid, on the third Monday of January in every Year, of which Meeting and Election, or of any ſpecial Meeting that ſhall be held, Public Notice ſhall be given by the Preſident and Managers of at leaſt three Weeks, in one or more of the Public News-papers in Philadelphia.

9 THAT the Company ſhall from Time to Time make ſuch Rules, Regulations and

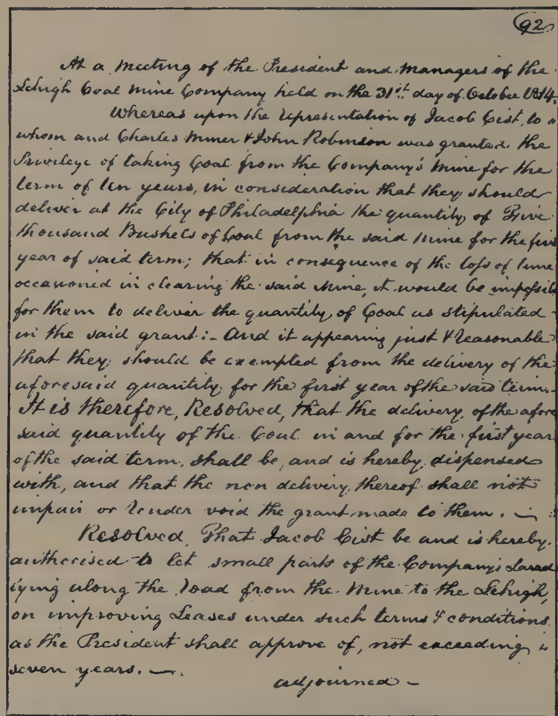
136 From a circular dated Feb. 13, 1792, courtesy of the Lehigh Coal and Navigation Company, Philadelphia

JACOB CIST INTRODUCES COAL INTO PHILADELPHIA

AT first the Lehigh Coal-Mine Company did not meet with success. People would not buy the untried fuel. Consequently the company was glad in 1813 to lease the rights of mining its property for ten years to a group of men headed by Jacob Cist on condition that they deliver five thousand bushels of coal to Philadelphia during the first two years and ten thousand bushels for the remaining eight years. Cist and his associates, however, failed to carry out the agreement and the lease was cancelled.

THE FORMATION OF THE LEHIGH COAL-MINE COMPANY

THE first anthracite mining company to attract notice was the Lehigh Coal-Mine Company. A story is told of a poor hunter named Philip Ginter who in 1791 accidentally kicked up some coal in the neighborhood of Mauch Chunk. Startled, he picked up the stones and carried them to Col. Jacob Weiss, who in turn sent them to Philadelphia for analysis. At any rate, in 1792 Weiss, together with John Nicholson, Michael Hillegas, and others formed the Lehigh Coal-Mine Company with the purpose of exploiting the anthracite resources of the Mauch Chunk neighborhood.



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At a Meeting of the President and Managers of the Lehigh Coal Mine Company held on the 31st day of October 1814.

Whereas upon the representation of Jacob Cist, to whom and Charles Miner & John Robinson was granted the Privilege of taking Coal from the Company's Mine for the term of ten years, in consideration that they should deliver at the City of Philadelphia the quantity of Five thousand Bushels of Coal from the said Mine for the first year of said term; that in consequence of the loss of time occasioned in clearing the said Mine, it would be impossible for them to deliver the quantity of Coal as stipulated in the said grant:— And it appearing just & Reasonable that they should be exempted from the delivery of the aforesaid quantity for the first year of the said term. It is therefore, Resolved, that the delivery of the aforesaid quantity of the Coal in and for the first year of the said term, shall be, and is hereby dispensed with, and that the non delivery thereof shall not impair or render void the grant made to them.

Resolved, That Jacob Cist be and is hereby authorised to let small parts of the Company's Land lying along the Road from the Mine to the Lehigh, on improving Leases under such terms & conditions as the President shall approve of, not exceeding seven years.—

adjourned—

137 Facsimile from the daybook of the Lehigh Coal-Mine Company for Oct. 1814, courtesy of the Lehigh Coal and Navigation Company

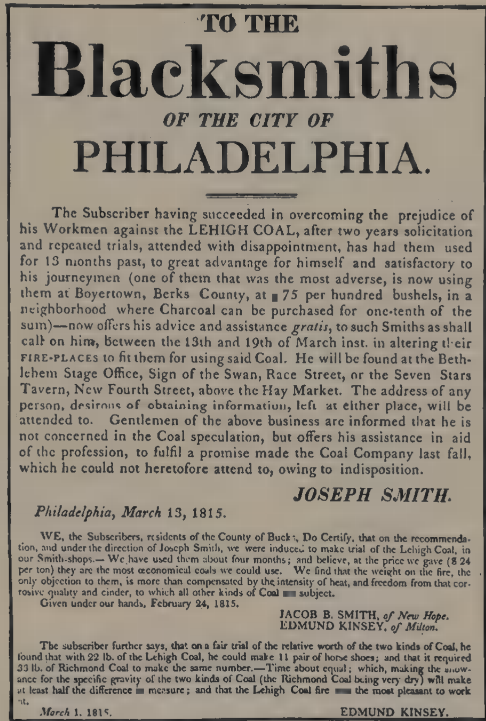
138 From a lithograph in the *American Journal of Science and Arts*, New Haven, 1822

AN EARLY COAL MINE

ONE of the first coal mines to do active business was that of John and Abijah Smith, organized about 1805. In 1807 they sent fifty-five tons of coal from Wilkes-Barre by water down the Susquehanna to Columbia.

OVERCOMING THE PREJUDICE AGAINST ANTHRACITE

The trouble in selling anthracite lay in the unwillingness of the public to try something new. What an unheard of thing to burn black stones! The Lehigh Coal-Mine Company published handbills or broadsides in order to convince the public of the practicability of anthracite as a fuel.



TO THE

Blacksmiths

OF THE CITY OF

PHILADELPHIA.

The Subscriber having succeeded in overcoming the prejudice of his Workmen against the LEHIGH COAL, after two years solicitation and repeated trials, attended with disappointment, has had them used for 13 months past, to great advantage for himself and satisfactory to his journeymen (one of them that was the most adverse, is now using them at Boyertown, Berks County, at [redacted] 75 per hundred bushels, in a neighborhood where Charcoal can be purchased for one-tenth of the sum)—now offers his advice and assistance *gratis*, to such Smiths as shall call on him, between the 13th and 19th of March inst. in altering their FIRE-PLACES to fit them for using said Coal. He will be found at the Bethlehem Stage Office, Sign of the Swan, Race Street, or the Seven Stars Tavern, New Fourth Street, above the Hay Market. The address of any person, desirous of obtaining information, left at either place, will be attended to. Gentlemen of the above business are informed that he is not concerned in the Coal speculation, but offers his assistance in aid of the profession, to fulfil a promise made the Coal Company last fall, which he could not heretofore attend to, owing to indisposition.

JOSEPH SMITH.

Philadelphia, March 13, 1815.

WE, the Subscribers, residents of the County of Bucks, Do Certify, that on the recommendation, and under the direction of Joseph Smith, we were induced to make trial of the Lehigh Coal, in our Smith-shops.—We have used them about four months; and believe, at the price we gave ($ 24 per ton) they are the most œconomical coals we could use. We find that the weight on the fire, the only objection to them, is more than compensated by the intensity of heat, and freedom from that corrosive quality and cinder, to which all other kinds of Coal [redacted] subject.

Given under our hands, February 24, 1815.

JACOB B. SMITH, *of New Hope.*
EDMUND KINSEY, *of Milton.*

The subscriber further says, that on a fair trial of the relative worth of the two kinds of Coal, he found that with 22 lb. of the Lehigh Coal, he could make 11 pair of horse shoes; and that it required 33 lb. of Richmond Coal to make the same number.—Time about equal; which, making the allowance for the specific gravity of the two kinds of Coal (the Richmond Coal being very dry) will make at least half the difference [redacted] measure; and that the Lehigh Coal fire [redacted] the most pleasant to work at.

March 1, 1815. EDMUND KINSEY.

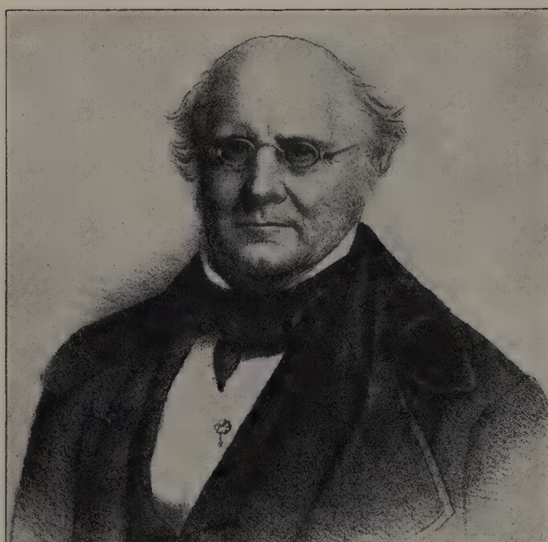
139 Facsimile of a circular in the collection of the Lehigh Coal and Navigation Company

140 Josiah White, 1781–1850, from M. S. Henry, *History of Lehigh Valley*, Easton, Pa., 1860, lithograph from drawing on stone by A. Newson

THE FIRM OF WHITE AND HAZARD

At this point the firm of White and Hazard enters the story. In 1813 this firm was engaged in the manufacture of iron and wire at the falls of the Schuylkill. Becoming interested in anthracite, they experimented with it to discover its fitness for their business. At first they treated it like bituminous coal; that is, they used a small draft, frequent firing, and constant poking. Under these conditions the anthracite failed to burn properly.

One day, one of their men in disgust slammed shut the furnace door, left the drafts open, and went home. His astonishment was exceedingly great when on his return he discovered a brisk fire burning in the furnace. This accident pointed the way to proper firing with anthracite; White and Hazard soon mastered the use of the new fuel.



141 Erskine Hazard, 1789–1865, from M. S. Henry, *History of Lehigh Valley*, Easton, Pa., 1860, lithograph from drawing on stone by A. Newson

Realizing the value of anthracite, they now set about making a connection with the coal industry. Since they had bought their coal from the Lehigh Coal-Mine Company, they attempted to get into a position to deal with its owners. Accordingly, in 1818, they obtained a charter from the legislature to improve the navigation of the Lehigh River, and formed the Lehigh Navigation Company. They also bought coal land in the neighborhood of Mauch Chunk. Interesting some of the members of the older company in their project, they were able to lease the old company from its owners for twenty years. This lease, however, did not run out its term, for in the following year the two companies were consolidated.

142 From a lithograph in the *American Journal of Science and Arts*, New Haven, 1831

EARLY MINING AT MAUCH CHUNK

THE Mauch Chunk mines were the most famous American mines of their time. Foreign travelers made as great efforts to see them as they did to view Niagara Falls, and in their books of travel gave glowing accounts of these unique works.

Mining in the Mauch Chunk region was no easy task. The mines were at the top and sides of the hill surrounding the village. All supplies had to be hauled over the ridges, and all coal let down the hillside — at first to the river level, and later to the railroad track. The Lehigh valley, at this point a narrow, winding gorge, was of surpassing beauty, but with the advent of man and his works a dark pall has fallen upon the blackened valley.

GRAVITY COAL PLANE AT MAUCH CHUNK

THE peculiar transportation difficulties at Mauch Chunk, for which horses and wagons were hardly adequate, were met by the introduction of the railroad. These gravity railroads were among the earliest in the United States. Loaded coal cars as they descended were made to pull loaded supply cars up the hill. Mules also pulled cars on rails uphill. Trains of coal cars were made up at the top of the hill and the mules rode downhill in a car attached to the rear. Eventually steam engines operated cables to which cars were attached. The Mauch Chunk mines with their elaborate railway mark the transition from the age when practically no coal was used, to the modern industrial era.

143 From M. S. Henry, *History of Lehigh Valley*, Easton, Pa., 1860, after an ambrotype by P. H. Osborn

144 From William Henry Pyne, *Microcosm, or a picturesque delineation of the Arts, Agriculture, Manufactures . . . etc. of Great Britain*, London, 1808

BRITISH COLLIERY WORKERS ABOUT 1800

UNLIKE anthracite, bituminous coal was mined in Europe long before its discovery in America. No history of American coal would be complete without an acknowledgment of our indebtedness to the Old World for methods of mining and knowledge of the utility of the fuel. Our direct inheritance, here as in other things, is from England. In fact, our first miners were men who had gained their experience in the mines of Britain.

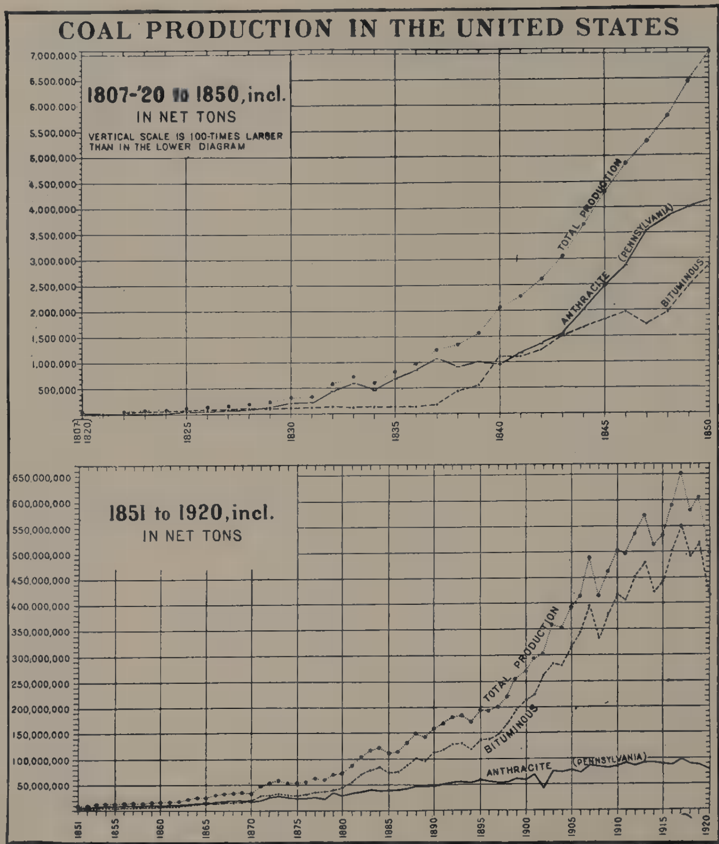
145 A Bituminous Coal Seam on the Monongahela, from Charles Lyell, *Travels in North America*, London, 1845

BEGINNINGS OF BITUMINOUS MINING IN AMERICA

SOFT coal mining began in the neighborhood of Richmond in 1750, but it did not reach great proportions until after the anthracite fields had been well established. The great extent of the bituminous fields early became evident, travelers to the westward often remarking on the great seams of exposed coal. In No. 145 (*a*) represents the coal which Lyell, the traveler, declared to be ten feet thick, (*b*) the shale and (*c*) sandstone. At the extreme right front is a mine in operation. Lyell described it as follows: "Horizontal galleries may be driven everywhere at slight expense and so worked as to drain themselves, while the cars laden with coal and attached to each other glide down as shown in the plate, on a railway so as to deliver their burden to barges moored to the river's bank."

Many of the soft coal veins, like the one at Pomeroy (No. 146), were discovered on the slopes of rivers. This favorable location permitted cheap water transportation.

146 A Waterside Coal Mine at Pomeroy on the Ohio, from Henry Howe, *Historical Collections of Ohio*, Cincinnati, 1847

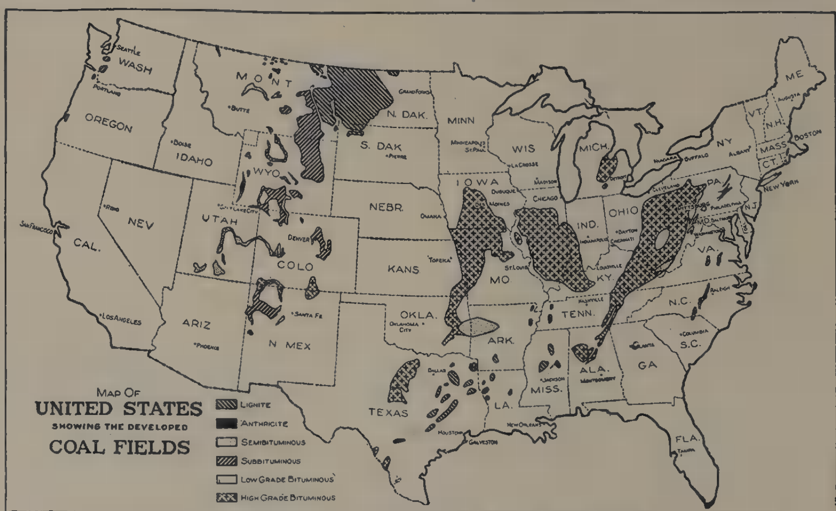


147 Drawn expressly for *The Pageant of America*, by Gregor Noetzel from data compiled by the United States Geological Survey

ANTHRACITE *VERSUS* BITUMINOUS

Up to about 1870 the production of anthracite surpassed that of bituminous. This was due to the earlier start obtained by anthracite, its location in the East, and its use in the steel industry. From 1870 the production of bituminous left anthracite far behind, and its production is now *comparatively* negligible.

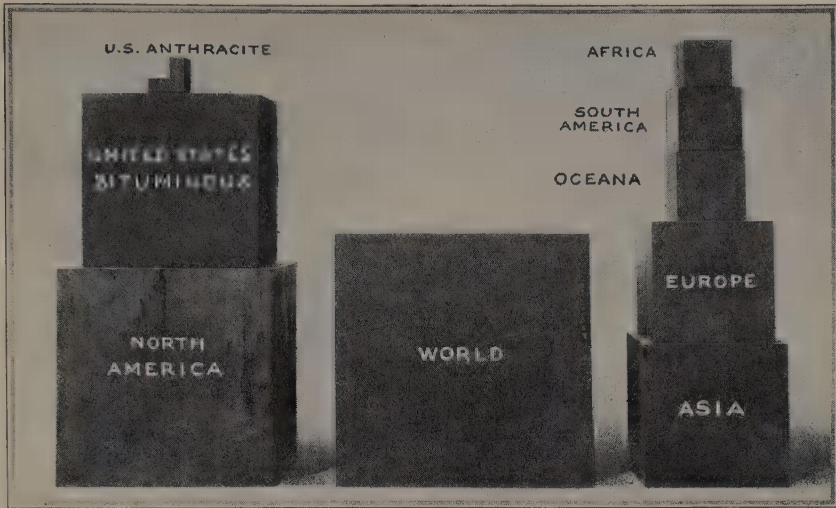
A map of the coal fields of the United States will give a clew to the reason why anthracite is of so little importance compared with bituminous. The anthracite area is very small, only a thin line in eastern Pennsylvania and a touch in Rhode Island. There are about 490 square miles of anthracite and over 500,000 square miles of land bearing bituminous coal. Bituminous is now the preëminent industrial fuel and is capable of indefinite expansion, whereas anthracite is almost entirely limited to household use. Even there it has passed its peak of possible production and seems sure to decline as years pass, due to the development of other heating methods, such as gas, oil and electricity.



148 From Frank G. Baum, *Atlas of U. S. A. Electric Power Industry*, San Francisco, 1923, from data compiled by the United States Geological Survey

COMPARATIVE COAL SUPPLIES OF THE WORLD

In comparing our coal resources with those of the rest of the world a very small block serves to represent American anthracite. The nick in this block shows the amount of anthracite already consumed. A similar reduction of the bituminous cube would make too small an indentation to show.



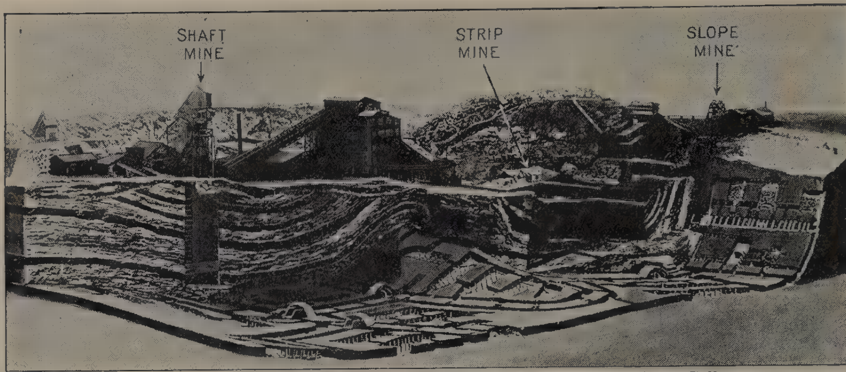
149 From an exhibit in the United States National Museum

150 From a model in the United States National Museum

CROSS SECTION OF A COAL MINE

The operations at the coal mine are divided into two distinct parts, those above ground, and those below. Under the earth are numerous passageways leading in many directions. Along these passageways miners dig the coal and send it to the surface. Above ground are the buildings where the coal is received and prepared for market, the railways that distribute the coal, and the homes of the miners.

TYPES OF COAL MINES

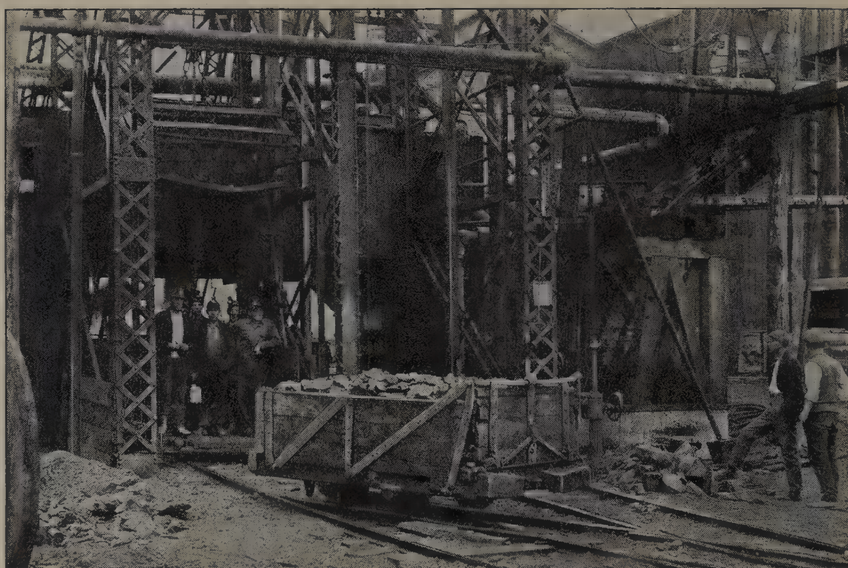


151 Model of Anthracite Mines, from the Mining Museum, Pennsylvania State College

COAL mines are named among miners in accordance with the method of approach from the surface to the vein. In the shaft mine a vertical bore comes down from the surface to the lower beds. The coal as it is mined is elevated in the shaft to the surface buildings. Where the beds of coal are nearly vertical a "slope" is driven toward them from the surface behind the beds. This connects with the entries or tunnels along the vein at the bottom of the "slope," and the vertical section is then worked by breaking the coal out of the beds and letting it fall down where it may be gathered and transported to the surface. In the strip mine there is no bore. The coal cropping out of the surface is removed by a steam shovel in much the same manner as sand. The use of such machinery in such favorable localities is one of the reasons why the American miner digs more tons of coal in a year than any of his foreign rivals.

152 Stripping Coal, courtesy of *Coal Age*, New York

MINE CAGE AT THE SHAFT TOP



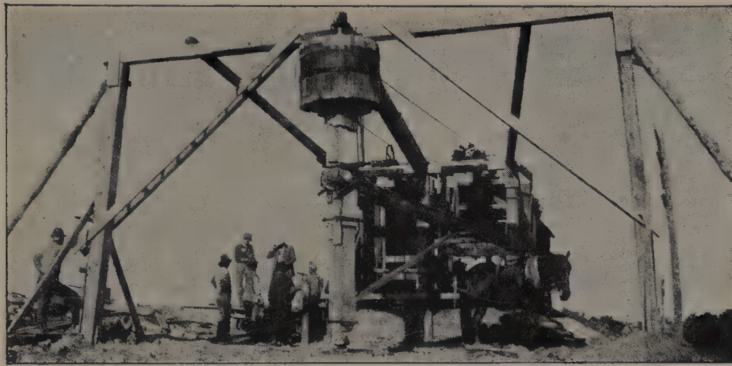
153 Courtesy of *Coal Age*

ALTHOUGH slope, drift, and tunnel mines are common in hill and valley regions where the veins located within the hillsides above the valley make these methods of mining possible, the ordinary mine is of the shaft variety. Up and down the shaft an elevator called a "cage" is operated. Miners going to and coming from work are lowered or lifted in the cage. Likewise, all filled coal cars from the mine faces are brought to the bottom of the shaft, shifted on to the cage, and hoisted to the surface. Empty cars are returned in the same manner.

The modern mine cage is raised or lowered by steam or electric power at a faster rate than the most expeditious office elevator. In deep mines the time taken in reaching the work level by workers or hoisting cargoes to the surface is an important item in the economy of the operations.

OLD-TIME HORSE HOIST

THE early cages were raised and lowered by a winch or turnstile. No contrast better illustrates the more efficient methods of the present day than that of the swiftly moving modern cage contrasted with its early counterpart hoisted slowly by a horse moving in a circle about the winch.



154 From a photograph by the United States Bureau of Mines

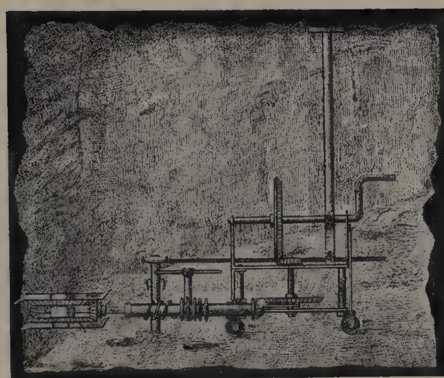
155 From a photograph by the United States Bureau of Mines

PREPARING TO BLAST A VEIN

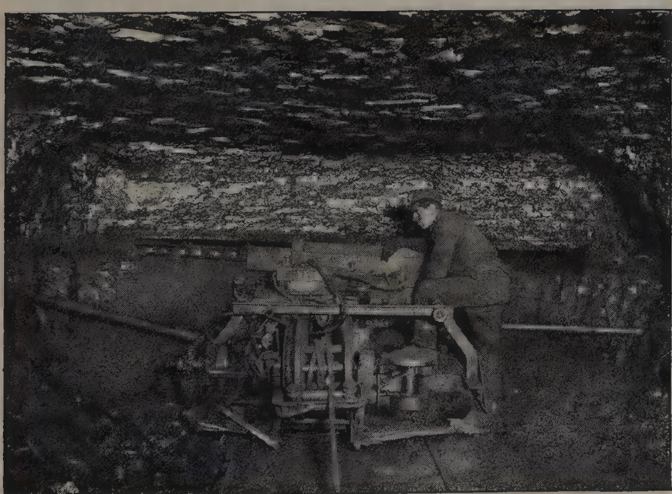
THE first step in mining is the breaking down of the coal from the face of the mine. A groove is cut at the bottom of the face of the vein and holes are bored at the top. Then the coal between the two openings is broken down. At first miners used picks to cut the grooves, and wedges to loosen the coal. Later the use of explosives came into vogue. Into the holes drilled in the face of the vein light charges of powder were poured and rammed home or "tamped." A fuse was inserted and the explosion that resulted blew down the coal, which was then ready for shoveling into the cars.

A PATENT COAL-CUTTING MACHINE, 1865

THE hardness of anthracite early suggested the use of mechanical devices for undercutting and boring. One of the earliest machines is here shown (No. 156). It was worked by hand power.



156 From *The Growth of Industrial Art*, Washington, 1892



157 Courtesy of the Jeffrey Manufacturing Company, Columbus, Ohio

A MODERN COAL CUTTER

THE modern undercutting machine is a complicated device. The cutting tools in the machine shown are carried in a continuous chain. This mechanism accomplishes in a short time work that formerly took many hours.

COMPRESSED AIR DRILL

MECHANICAL tools once introduced were rapidly improved. Compressed air and electricity now supply the power for coal-mining machines. One of the many varieties of mechanical drills is here shown. The rapid staccato pounding of the modern drills echoes through passageways deep underground.

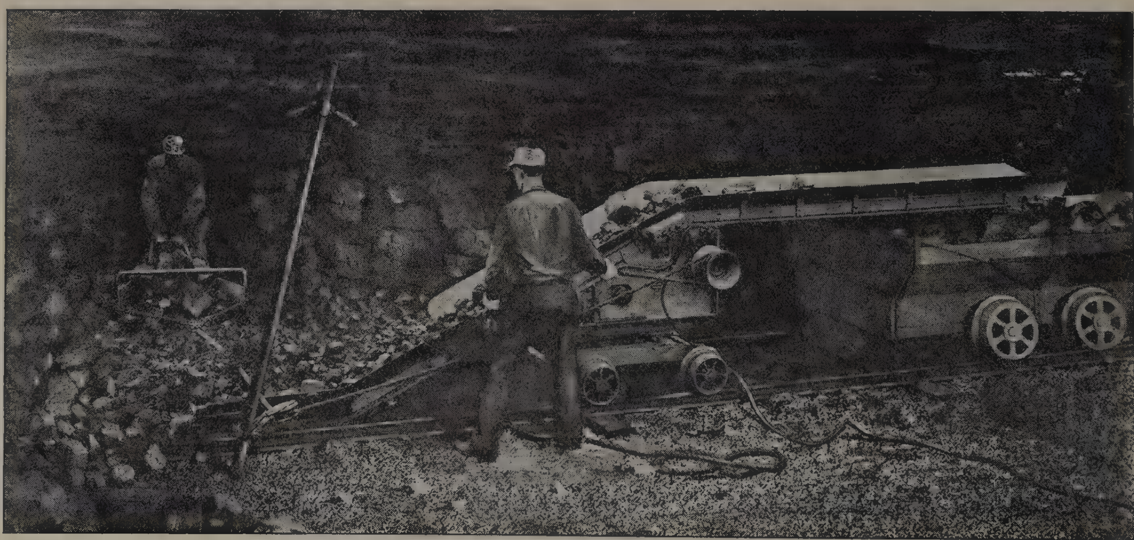
158 Courtesy of the Ingersoll-Rand Company, New York

159 Loading Coal by Hand, from *Harper's Weekly*, Sept. 11, 1869

OLD AND NEW WAYS OF LOADING COAL

AFTER the coal is broken down it is loaded into cars and brought to the surface. For many years coal was shoveled by hand, a heavy and slow task requiring many laborers for rapid output. The cars were then drawn by mules along the passageways in the mines to the bottom of the elevator or to the slope leading to the surface.

Shoveling was the last underground job to yield to machine operation. A mechanical loader has only recently been invented and is gradually coming into general use.

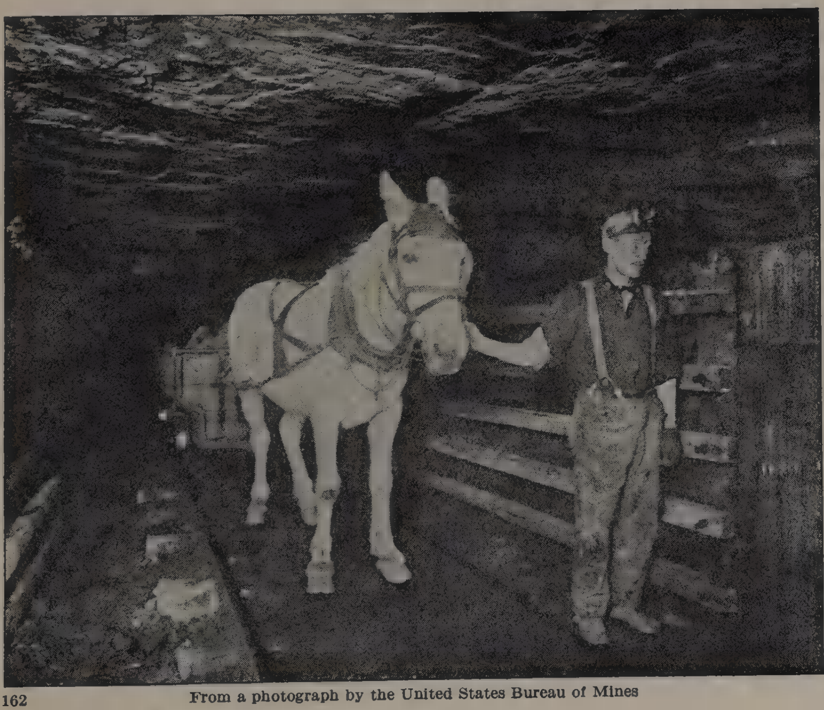


160 A Mechanical Loader, courtesy of the Jeffrey Manufacturing Company

161 Courtesy of the Jeffrey Manufacturing Company

COMBINATION CUTTER, BREAKER, AND LOADER

One of the latest machines is the three-in-one cutter. This device not only undercuts the coal, but breaks it down and loads it in cars. It eliminates so much labor that it is likely to meet with severe opposition as its use becomes more general. Because anthracite is harder than bituminous and also for the reason that the veins are thinner, machinery is much less generally employed in hard coal mining than in soft.



162 From a photograph by the United States Bureau of Mines

MINE MULE HAULING A LOAD

For hauling cars within the mines there have been and are many methods: human muscle, gravity, and cable and windlass. But the mine mule, stabled underground, was for many years the favorite "power" for hauling cars. Ultimately, however, his service was challenged by engines, some run by compressed air, and some by steam. Of late the electric locomotive has superseded all other means of car movement in the best equipped mines. Despite the new methods the old-time mule is still found in many mines, laboring at his ancient task.

163 Courtesy of the Jeffrey Manufacturing Company

164 A Wooden Breaker, courtesy of *Coal Age*

THE SUCCESSOR OF THE MINE MULE

If the old-time mule had a dangerous kick, so has the electric locomotive. Observe how close the feed wires are to the men's heads. The passageway is lighted with electric bulbs inserted in the roof. This kind of lighting is confined to main passages.

THE BREAKER

When the great lumps of anthracite reach the surface they must be "manufactured" for domestic use by separating coal from slate and sorting the coal into the customary trade sizes from "furnace" to "buckwheat." This is done in a series of buildings called the "breaker." Older breakers were made of wood but the most modern are constructed of concrete. The waste material or culm is dumped in mountainous piles that encumber the whole anthracite area. Past these great heaps flow black and polluted streams.

165 A Modern Breaker, courtesy of the General Electric Company

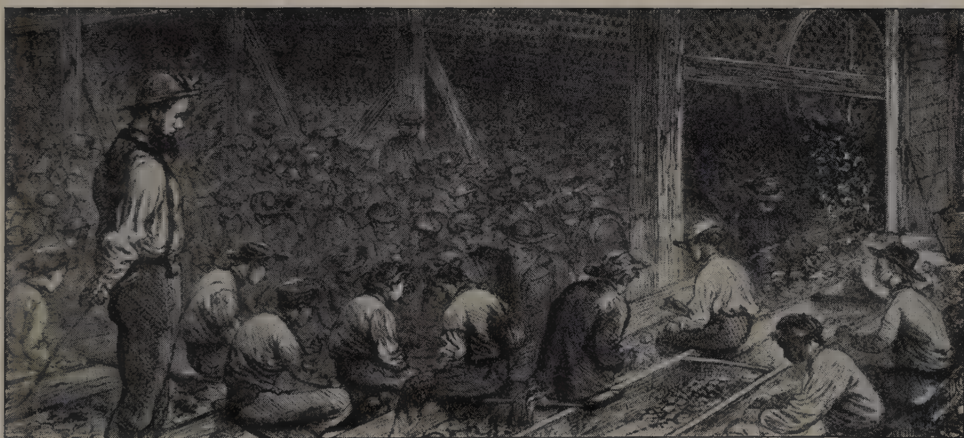
OLD METHOD OF SEPARATING SIZES

In an old-time breaker the lumps of anthracite were cracked into smaller bits by hand sledges and passed through a screen that sorted sizes.

SLATE PICKING IN THE 'SIXTIES

On benches at intervals along the coal chutes sat the breaker boys under the supervision of a foreman. As the lumps of coal passed slowly down the slide at their feet, these lads picked out the pieces of slate that were mixed in and threw this refuse into a parallel chute. At the top of the chute worked the inexperienced boys, while hands long familiar with the task picked out the last pieces of stone as the coal passed on to other processes. The breaker, noisy and dirty, with its never-ending stream of coal passing the benches, warped and stunted hundreds of human lives.

166 From *Harper's Weekly*, Sept. 11, 1869, after a drawing by Theodore R. Davis



167 From *Harper's Weekly*, Sept. 11, 1869, after a drawing by Theodore R. Davis

168 From a photograph by the United States Bureau of Mines

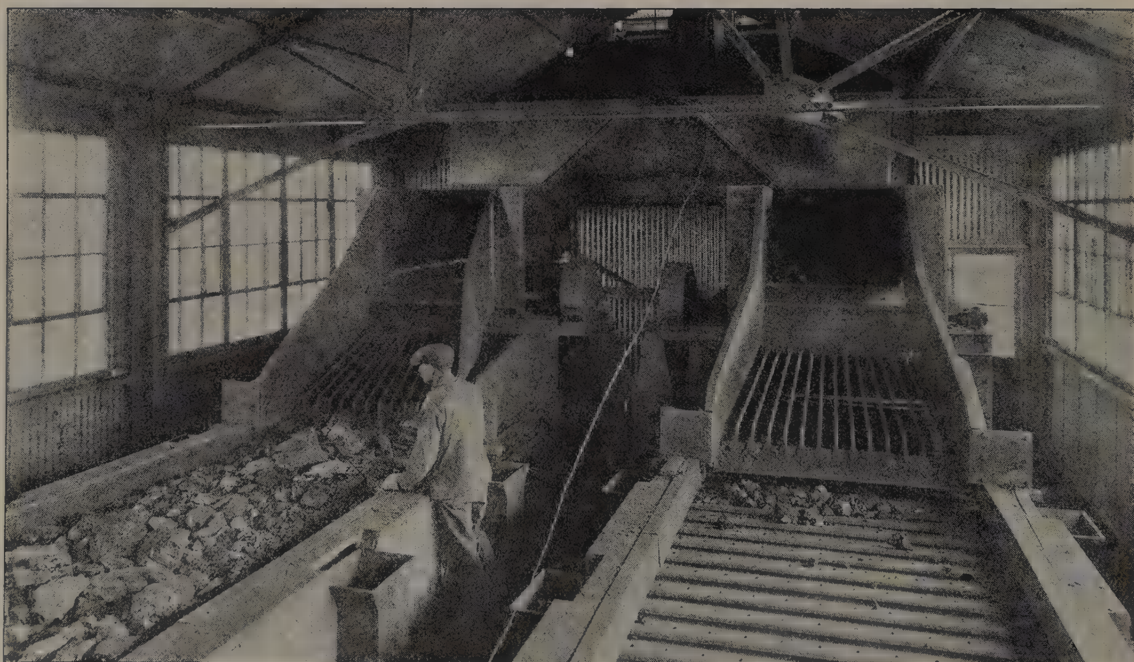
MODERN SORTING SCREENS

A modern breaker crushes the great lumps in a machine and passes them to sorting screens. Thence the mass goes into other machines which mechanically separate slate from coal by utilizing the difference in weight and specific gravity of the two substances, coal being the lighter of the two.

169 Courtesy of the Jeffrey Manufacturing Company

TIPPLE FOR A BITUMINOUS MINE

The surface building where bituminous coal is received is called a "tipple." In this structure coal is weighed and then dumped into railway cars or boats. The shaft at the left of the tipple operates the mine elevator or "cage."



170 Courtesy of the Jeffrey Manufacturing Company

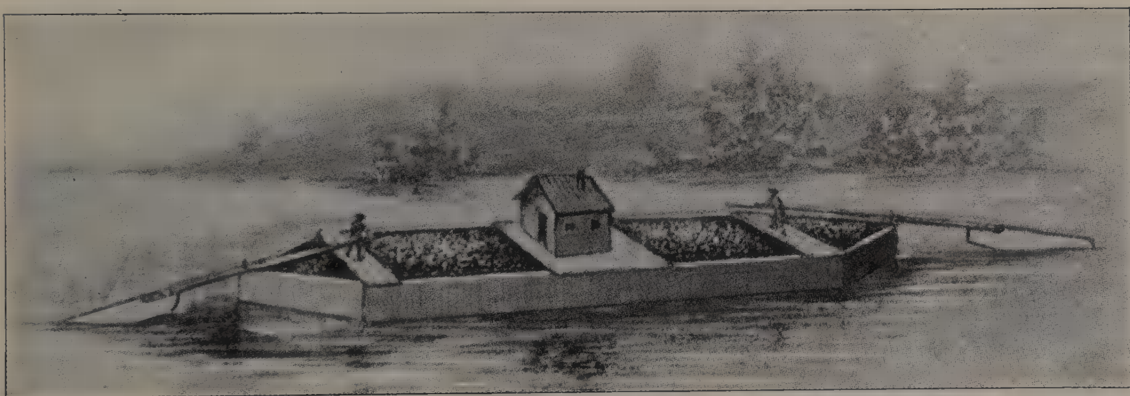
HEAD OF PICKING TABLE IN A TIPPLE

In the interior of a tipple, workers break the largest lumps of coal into smaller pieces, much as is done with anthracite in a breaker.

LOADING A COAL BOAT ON THE LEHIGH CANAL

171 From *Harper's Weekly*, Feb. 22, 1873, after a drawing by Frenzeny

TRANSPORTATION is an important factor in coal mining as in many other industries. In colonial days the name "sea coal" was generally given to this product because it came from England in ships. Some of the first loads of domestic coal were transported on horseback and in wagons. But the fact that the early mines were generally located near navigable rivers suggested the use of the Lehigh, Schuylkill, and Susquehanna for the transportation of coal. The rivers were improved and canals were built for better transportation through them. The coal was sent down long chutes to the river bank, where the canal boat received it.



172 From the Wyoming Historical and Geological Society *Proceedings*, Vol. X, Wilkes-Barre, Pa., 1909

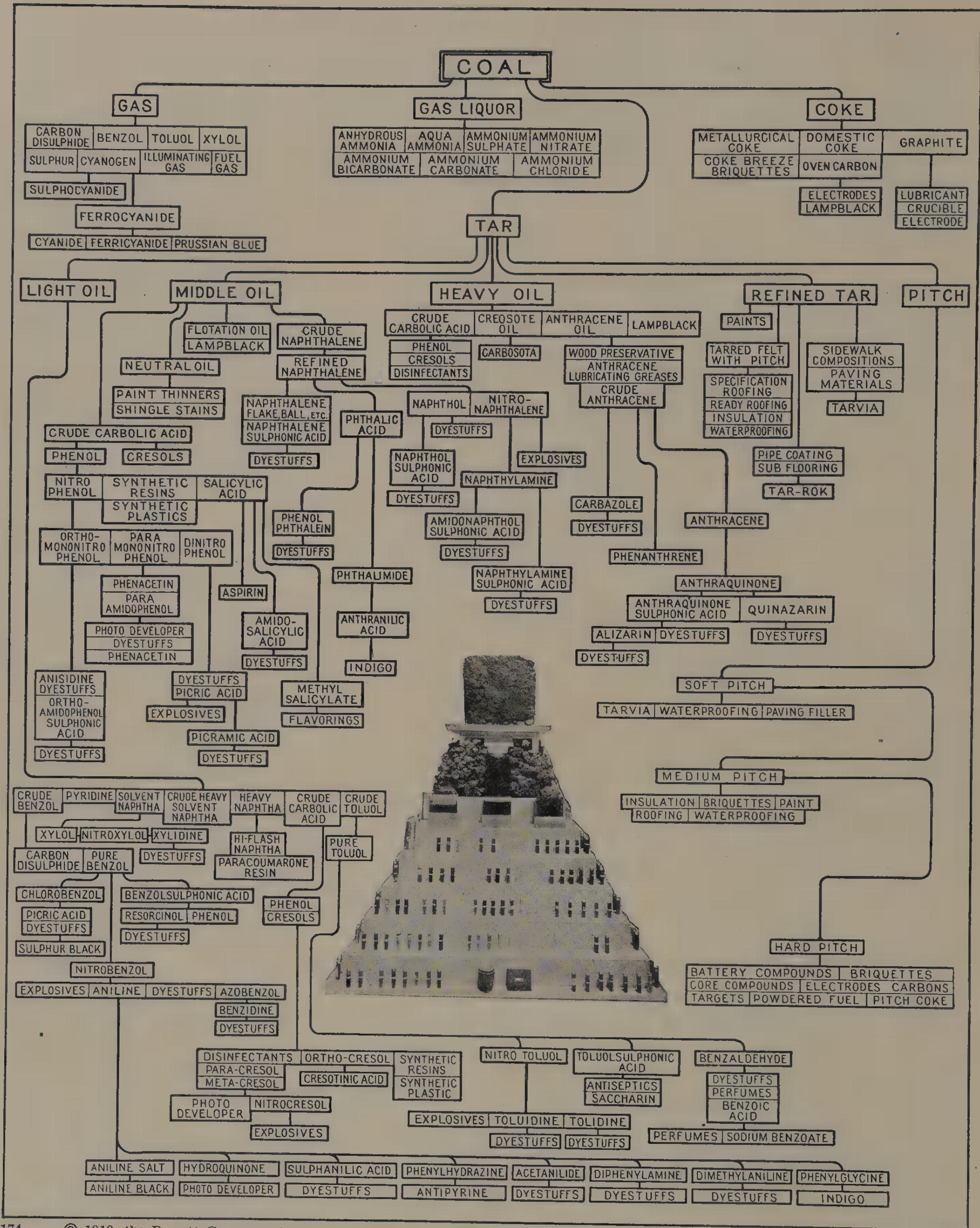
COAL "ARK" ON THE SUSQUEHANNA, 1808

COAL "arks" preceded the appearance of canal coal boats. The arks were built of timbers grown near the mines. When they arrived at their destination, the coal was removed and the ark broken up to be sold for lumber.

A RAILWAY YARD FILLED WITH COAL TRAINS

TO-DAY coal is carried mainly by railroads. Every one is familiar with the long line of coal cars passing across the country. The transportation of coal forms one of the chief sources of revenue to the railroads of America.

173 Courtesy of *Coal Age*



174 insert from an exhibit of coal products in the United States National Museum

A LUMP OF COAL AND SOME OF ITS BY-PRODUCTS

Coal is not simply a fuel to be burned. Like petroleum, it may be distilled into a great variety of useful by-products. Indeed many of the things derived from petroleum may also be obtained from distilled coal. When these by-products have been taken from a lump of coal, a residuum remains which is a better fuel than the original material from the miner's pick.

175 From a model in the United States National Museum

AN OPEN COKE PILE

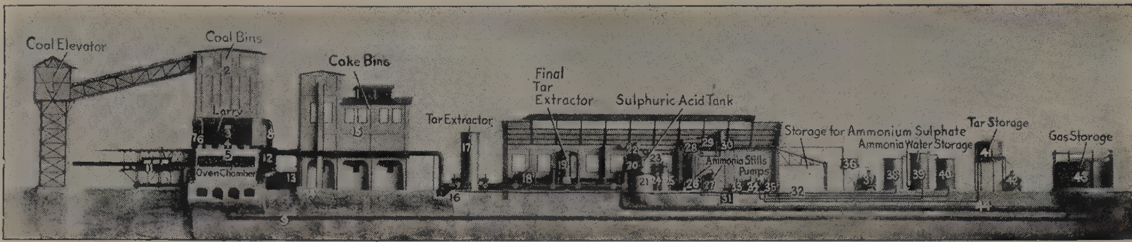
One of the important products obtained from coal is coke. The picture shows the earliest American method of coking coal. "The procedure started with an open heap of coal provided with a system of draughts as shown in the portion removed. The fire was kindled under the vertical flues and combustion was kept smothered by banking with powdered coal." — *Bulletin* 102, United States National Museum.

176 From a model in the United States National Museum

A BEEHIVE COKE OVEN

Closed ovens are now generally used in making coke. The most familiar type of coke oven is known as the "beehive." "An oven is charged through the top with five tons of coal, filling it to the height of the brick-work in the front opening, and the charge is gradually brought to distillation temperature by the heat communicated from the adjoining ovens. The escaping gases ignite and, burning in the dome of the oven, increase the heat, thus continuing the process of contributing heat as that in the adjoining ovens diminishes. The entrance of air being above the coal bed, combustion is kept confined largely to the gases in the dome. After 48 or 72 hours the residual coke is quenched with water, withdrawn, and a fresh charge of coal introduced." — *Bulletin* 102, United States National Museum. This method, as the diagram shows, is less wasteful than the earlier one, but it is nevertheless unsatisfactory: it not only wastes most of the valuable properties of coal, but also injures the neighborhood in which the coke is manufactured. Its advantages are the relative simplicity of construction and operation together with the excellence of the product.

177 General Appearance of a Wasteful Beehive Coke Oven, courtesy of the Mt. Pleasant (Pa.) Coke Co.

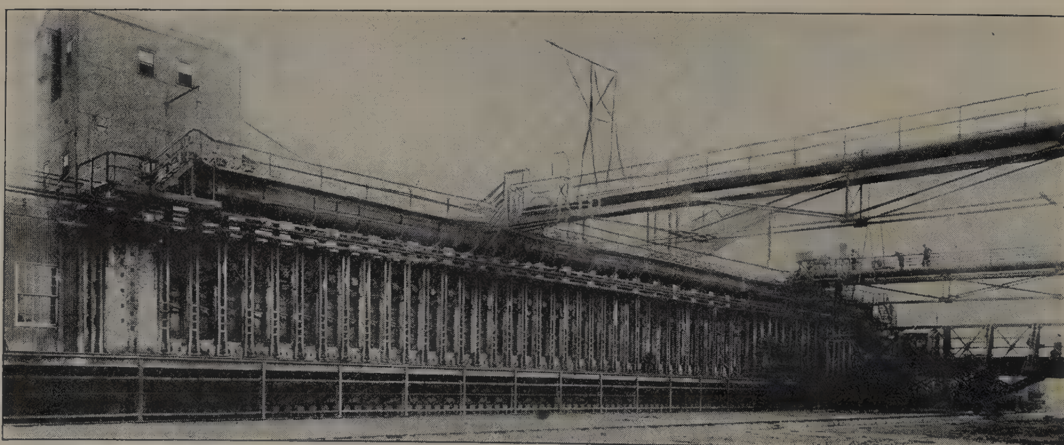


178 From a wash drawing after a panel in the United States National Museum

BY-PRODUCT COKING OPERATIONS

WASTEFULNESS has from the beginning been a characteristic of American civilization. When our vast national supplies of coal were realized, little effort was made to utilize fully the wealth contained in the black lumps. The modern method of producing coke is by the "by-product" coke oven. This saves every particle of useful matter in the coal, and is so little of a nuisance that it may be set up in a city. The most impressive feature of the process is the purely mechanical progress of the operations through their elaborate complexity.

"The coal-hoist (1) elevates the coal to the bins (2) from which it is fed by means of chutes into the charging car or "larry" (3). The larry is provided with a number of chutes corresponding to the series of openings (4) in the oven chamber (5). The ovens are long narrow rectangular chambers some 35 feet long, 20 inches wide, and 6 feet high, placed side by side in batteries of 50 or more. Thus an entire battery may be charged by a single larry operating along a track on top and from a single storage bin. On another track in front of the battery a device known as a coke-pusher (11) moves to and fro opening doors in the front ends of the ovens and pushing the finished coke out along a guide (12) to a car (13) both of which operate along the back end of the battery in coördination with the pusher. From the car the coke is dumped into the pit (14) from which it is elevated to the coke bins (15) for screening and sizing preliminary to shipment. The gases ascend through the pipes (6 and 7) into the main (8) leading to pit (16) where liquors condensing in transit are drawn off. Continuing through the tar extractor (17) the gases are forced by the exhauster (18) through the final tar extractor (19) and thence through the preheater (20) into the sulphuric acid tank (23). Here the free ammonia combines with the acid to form ammonium sulphate. The purified gas is piped through (44) to storage (43). The remaining liquid passes through the acid separator (22), the acid from there going to the acid pot (24) and the acid free liquor to the drier (25). The ammonium sulphate is here solidified and goes to storage (32). The other ammonium compounds join the liquor which has been previously drained into the pit (16). This liquor meanwhile has been pumped through the tar separating tank (39) whence the tar goes to storage (40) and then to shipping (41) in the tank car (42). The dilute ammonium separated from the tar goes to storage in (38), then pumped to the tank (28), through the ammonium still (26) where free ammonium is removed, and into the fixed ammonia still (27) where it is joined by the liquor from the sulphate operation. From (26) the free ammonia liquor goes to the return flow cooler (30) then through the final cooler (29) to shipping tank (36) for shipment in the tank car (37). Gas from the storage tank (43) is led by the pipe (9) to the ovens where it is used for heating the oven chamber when the next batch of coke is made." — *Bulletin* 102, United States National Museum.



179 A Bank of By-product Coke Ovens, from a photograph by the United States Bureau of Mines

180 From photographs by Lewis W. Hine

BRITISH MINERS

INDUSTRY has a human as well as a technical side. The risks and uncertainties of mining, and the importance of the industry in the national welfare combine to throw the life of the miner into high relief. Our earliest miners were from the British Isles; Scotchmen, Welshmen, and Englishmen, who had gained their experience in the coal mines of Great Britain and easily adapted themselves to the American industry. Even now many of these miners are to be seen in our coal fields, but they generally hold executive positions.

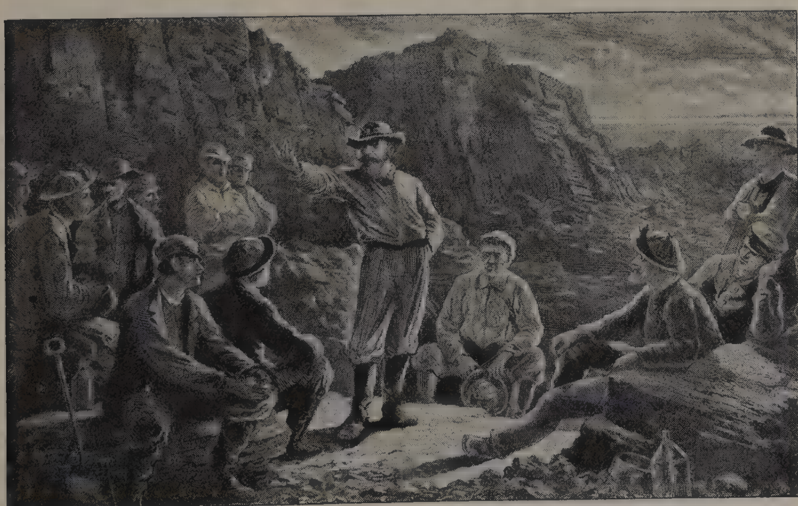
181 From a photograph by Lewis W. Hine

AN IRISH MINER

IN the 'fifties large numbers of Irish immigrants came to America and, in the next decade, they began to go into the coal fields. Intelligent and energetic, they won a place for themselves in the growing industry, though not so skilled in mining as their predecessors from the British Isles. In the 'seventies some of them in northeastern Pennsylvania combined into a secret organization known as the Molly Maguires, which terrorized the district for many years.

A MOLLY MAGUIRE MEETING, 1874

IN 1875 the Molly Maguires completely dominated the mining classes of the Pennsylvania coal regions. Taking the law into their own hands they instituted a reign of terror which was finally ended when sufficient evidence had accumulated in the hands of the state to warrant the arrest and prosecution of the leaders. The story of the Irish detective, James McPharlan, who joined the order to spy upon its members, rose to prominence in it, and finally, in an exciting trial, exposed the order and secured the conviction of its leaders is one of the great detective stories in American history. Of late the Irish, like the Scotch and Welsh, are primarily foremen, superintendents or labor leaders.



182 From *Harper's Weekly*, Jan. 31, 1874, after drawings by Frenzeny and Tavernier

183 A Czecho-Slovak Type, from a photograph by Lewis W. Hine

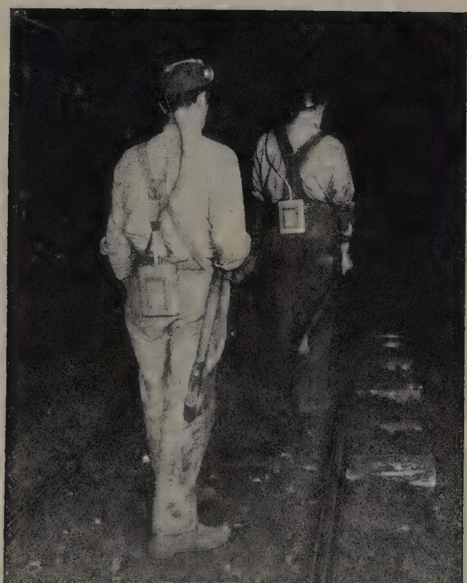
CZECHO-SLOVAKS AMONG THE MINERS

THE miners of to-day are composed of the mixed nationalities of central and southern Europe, the Slavic and Latin strains predominating among the workers. Coal mining is largely an immigrant industry and its operatives usually come from the prevailing immigrant type.

184 From a photograph by the United States Bureau of Mines

THE MINER AND HIS TOOLS

THE most picturesque item in the miner's equipment is his lamp. Without light underground operations would be almost impossible. For the most part miners use the time-honored torchlight in their caps, generally little cans of kerosene with open exposed wicks. Besides the cap, he must have picks and shovel, bars for drilling the holes for his explosive, and a sign to give warning of the blast, a sledge for breaking lumps, an ax to aid in the work of timbering, his explosives and — not the least — his dinner pail. To get all this equipment to the place of working underground is a task in itself.



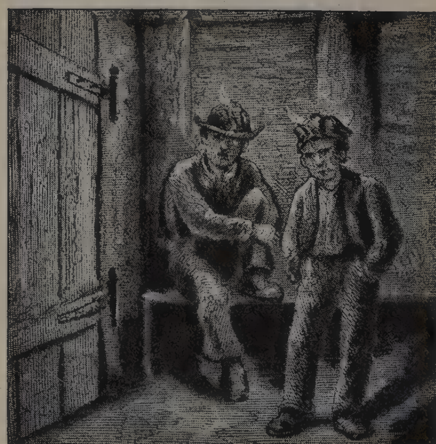
185 From a photograph by the United States Bureau of Mines

THE ELECTRIC CAP LAMP

SOME miners use cap lights supplied with gas from an acetylene tank strapped to the waist. Similarly electric batteries are worn at the waist and wired to an electric bulb worn on the cap.

BOY DOOR TENDERS

To the man working underground ventilation is as important as light. For the control of the air currents within the mine, doors were at an early date placed in the passageways. Certain of the doors had to be kept open and others closed. To insure that this was done boys were hired to tend the doors. This was one of the few places in the mine where child labor was possible and profitable. It is now prohibited by law, and as a result the doors are adjusted by the miners themselves, or by men door tenders and automatic door controls.



186 From *Harper's Weekly*, Feb. 22, 1873

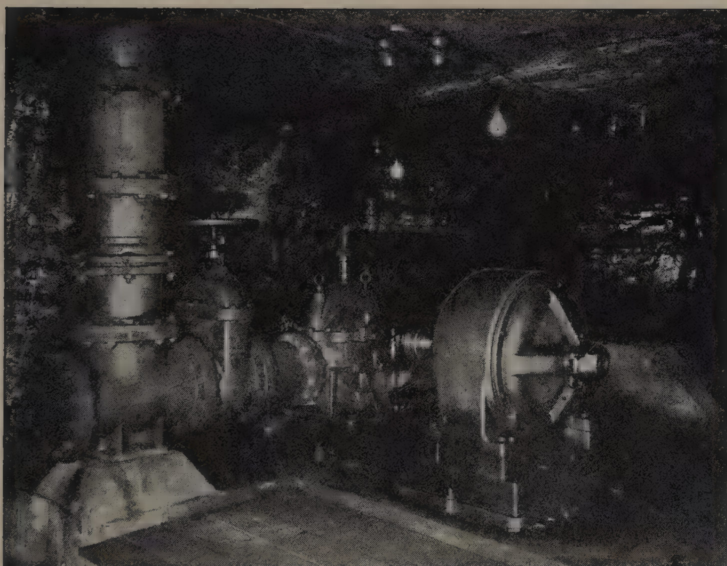
187 A Ventilating Fan Station, courtesy of the Jeffrey Manufacturing Company

THE LUNGS OF THE MINE

To deliver fresh air to the mine and remove foul air huge fans are erected at the surface. In the mining country a traveler passing perhaps through a wooded country of rolling hills will come suddenly upon a low fanhouse, the only indication in sight that beneath the surface are the passageways of a great mine extending far from the entrance shaft. The droning fan makes possible life and work underground.

KEEPING WATER OUT OF THE MINE

A HAZARD of the miner's life is the constant danger of a flooded mine. To prevent this, pumping machinery is installed in the mines and is always at work drawing out the water. From the anthracite mines is pumped more water daily than New York City uses. Since the pumps must operate whether any coal is mined or not, stoppages of work are costly.



188 From a photograph by the United States Bureau of Mines

DAVY'S SAFETY LAMP, 1815

ASIDE from water, another source of never ending danger is the explosive gas that seeps into the mine from the coal seams. In testing for the presence of gas and as a precaution in entering untested places, the safety lamp is used. The lamp, first made practicable by the famous British scientist, Sir Humphry Davy, is constructed upon the principle that a flame shielded by a close wire mesh does not readily ignite gas upon the other side of the mesh. Every group of miners has at least one safety lamp, and mine rules call for its exclusive use in dangerous or doubtful situations.

189 From the original in the South Kensington Museum

THE DAVY LAMP IN USE

A fire boss is testing for the presence of gas by watching the Davy lamp. When gas is dangerously abundant the flame will flicker although it will not ignite the gas, due to the intervention of the wire gauze. Although this is an old picture, the lamp and its use are the same to-day. Every morning before the miners go to their work places, the mines are tested for the presence of gas. One of the tasks in mine ventilation is the safe removal of such explosive gases. The care taken to guard against poisonous gas is but an illustration of the endless precautions that are necessary to protect the lives of the men who work underground.

190 From *Harper's Weekly*, Feb. 22, 1873

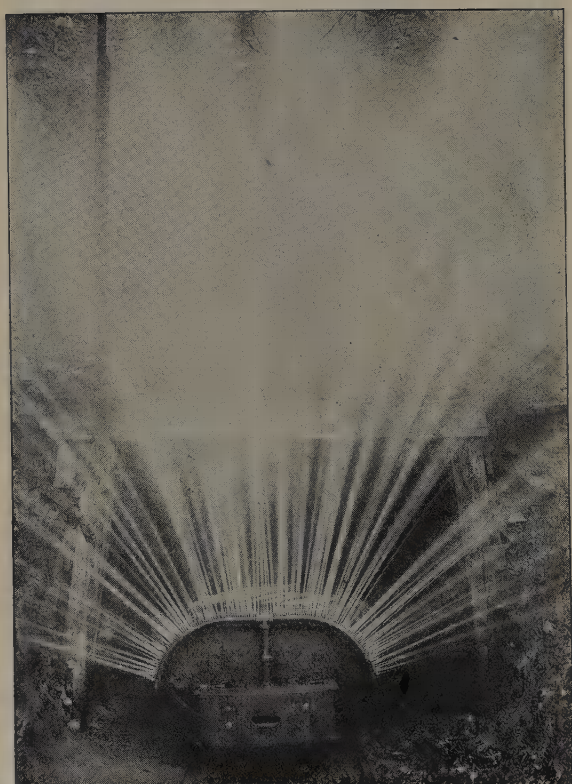
USING CANARIES TO DETECT THE PRESENCE OF GAS

Canaries are part of every mine's equipment. These birds are more sensitive to dangerous gases than men. By observing the birds in suspected gaseous areas, men are warned of their danger before real harm occurs. The birds are revived in fresh air, and are ready for further life-saving service.

191 From a photograph by the United States Bureau of Mines

SPRINKLER CAR AT MINE ENTRANCE

Mine-dust is likewise a dangerous explosive, especially in winter when the air and the mine are dry. One way of settling dust is by means of a water spray. Another is by adding noncombustible dust, such as that from crushed rocks, to the air currents in the mine. A dust explosion is a terrible occurrence. The men close at hand may be killed or badly wounded. Others in distant passageways may be imprisoned as a result of falling roofs. Such a disaster calls for rapid work to clear the obstruction and reach the entombed men cut off from food, water and air.



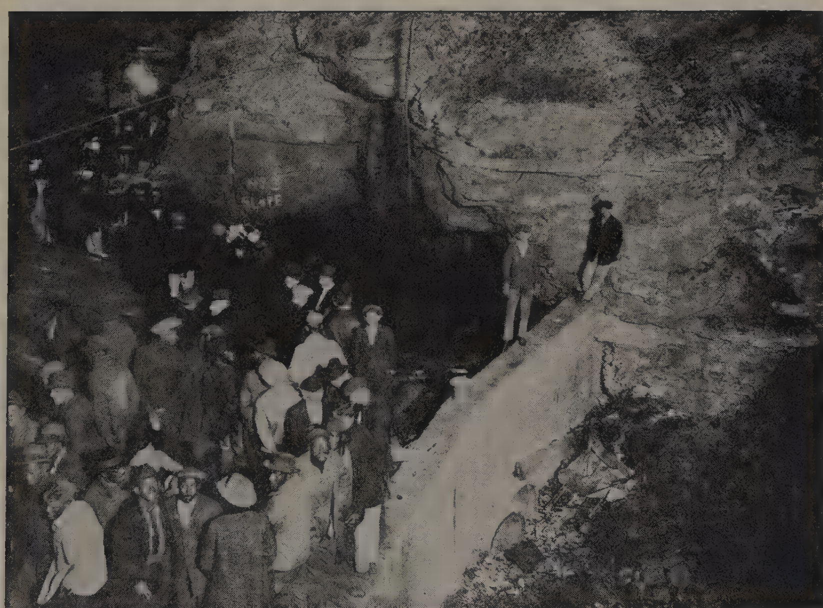
192 Courtesy of *Coal Age*

193 A First-aid Crew, from a photograph by the United States Bureau of Mines

THE TRAGIC SIDE OF MINING

COAL mining is one of the most hazardous of human occupations. From two thousand to three thousand mine workers are killed at work each year, and several times as many are injured more or less seriously. Accidents are caused by falling roofs, mine cars, locomotives and feed wires, gas or dust explosions, and unexpected explosions of the "shots" that blow down the coal. In preparation for accidents miners are organized into life-saving groups, trained in first-aid measures. There is much rivalry among the groups, and to foster it field days are held in which the various groups compete. Speed and efficiency in life-saving methods are the tests for which coveted awards are given. Some mines have fully equipped hospitals within the mine itself.

Since many accidents are the result of ignorance or carelessness, intensive education of mine workers in the hazards of their trade, and in the rules of first aid, has of late years been undertaken. One of the means of spreading knowledge is a car owned by the United States Bureau of Mines, equipped with safety and life-saving devices. Each of the principal mining areas has one of these cars and they are used not only in demonstrating safety measures, but, in case of calamity, are rushed to the scene for actual work in life-saving.



194 Scene of a Mine Blast in Alabama. © Keystone View Company

195 From *Harper's Weekly*, Feb. 22, 1873, after a drawing by Frenzeny

THE MINER'S PAY DAY

The home life of the miner presents many social problems not found in other communities. Among the factors which enter into his life are the difficulties and hazards of his occupation, his segregation in communities inhabited almost exclusively by men of his own trade, and the fact that the political and economic destinies of these communities are often in the hands of the mine owner. The situation is complicated by the fact that miners are all paid at one time and sometimes at relatively long intervals. Pay day is a day of mixed emotions. Joy of accomplishment rewarded, anticipation of purchases long denied, and surging lust for license all may be sensed in the crowd around the paymaster. These feelings too are shared by the workers' wives and families. Many a wife fears pay day as much as she hopes for it. When times are bad with the mines, the communities of miners where all are dependent upon the same source of income are desolate indeed.

THE OLD METHOD OF PAY CALCULATION

One of the most fruitful causes of industrial dispute has been the method of paying the miner for his work. To-day miners are paid by the weight of the coal mined and the weighing is done jointly by representatives of the company and of the miners. The old method was to give each miner metal tags, one for each car of coal. The miner attached his tag to the car which he filled. When it arrived at the opening leading to the surface, the tag was taken off and hung on a hook assigned to the miner. His pay was calculated on the basis of the number of tags on his hook, a method inexact and giving unlimited opportunity for chicanery. Quarrels and ill feeling between management and employees were the inevitable result of this rude system of measuring the work the miner had accomplished.

196 From *Harper's Weekly*, Feb. 22, 1873

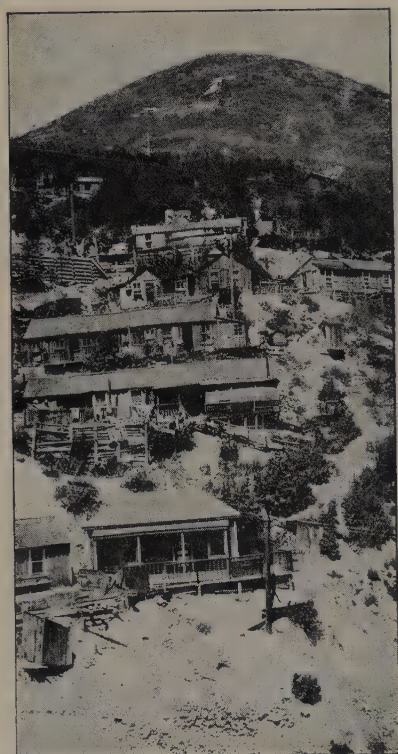
197 Ideal Living Conditions

MINERS' HOMES

The usual mining village is composed of plain, serviceable buildings, often standing starkly in rows with no attempt at variation or decoration. There are cozily built cottages as well, but few miners below the rank of foremen occupy such dwellings. On the other hand one frequently finds unpleasant housing conditions in the mining regions.

198 How the Average Miner Lives

199 A "Shanty" Town



200 Bad Housing

Four photographs by the United States Bureau of Mines

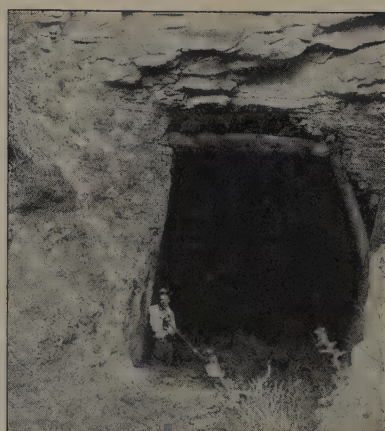
201 Farmer and Sons Digging Coal, courtesy of *Coal Age*

"SNOW-BIRDS"

UNLIKE the anthracite mines, which are highly localized, operated by large-scale methods, owned by eight large companies, and operated profitably three hundred days a year, the bituminous mines are found in thirty states, run by five thousand different operators, employing generally less than twenty men each, seldom as a whole making money, and idle from half to a third of a year. One of the causes of this contrast is the ease of mining bituminous coal. In many places it lies near the surface, and a farmer with his team can get supplies of coal as easily as loading sand. During the winter months when the demand is greatest, the price of bituminous coal advances. This fact encourages scores of individuals to start mining operations. These "snow-birds," as they are called, are always on a small scale, inefficient, and crudely operated. They completely disrupt the bituminous industry, and, largely because of their presence, the nation is overequipped with mining facilities. In fact, we have the facilities to produce yearly two hundred million tons more than we can use. To mine this coal we hold in reserve 175,000 more miners than we need, an enormous waste of man power. These men have to live, so their daily rate of pay is necessarily high to compensate them for the many days they do not work. This factor adds to the price of coal. The winter peak demand also puts a strain on the railroads at the very time they are taxed to move crops and have difficulties in contending with the weather. In the summer the railroads lose money because their cars stand idle on sidings.

202 Dog-Power Transportation, courtesy of *Coal Age*

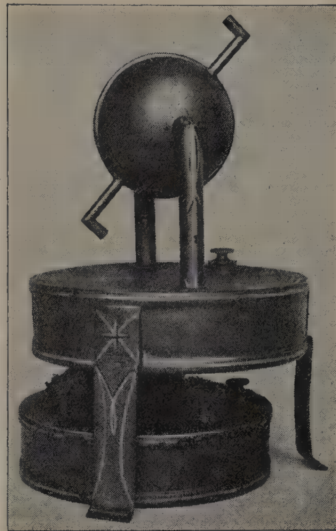
203 Trenching for Coal, Colorado, from a photograph by the United States Geological Survey



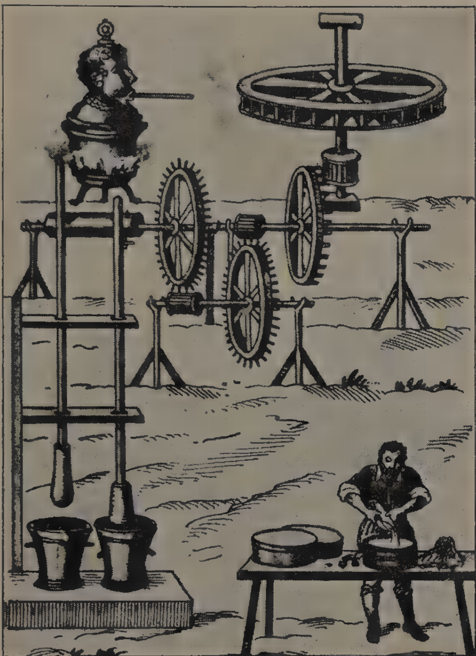
204 Wagon Mine, Utah, from a photograph by the United States Geological Survey

HERO'S STEAM DEVICE, *ca.* 50 A.D.

Long before coal became the chief source of steam power, experimenters were delving into the strange behavior of steam when it was produced, released, or directed in certain devices. Among the earliest recorded steam mechanisms is that of Hero of Alexandria, said to have been made about 50 A.D. This was a device in which a water vessel was heated by fire, making steam which, passing through two vertical hollow standards, entered a ball. The steam escaped from the ball through tangential nozzles that caused the ball to rotate. This and other steam devices invented by Hero were never more than toys. They served, nevertheless, to make clear that power is resident in steam and suggested that one day mechanical devices might be made to control that energy.



205 From a model in the United States National Museum



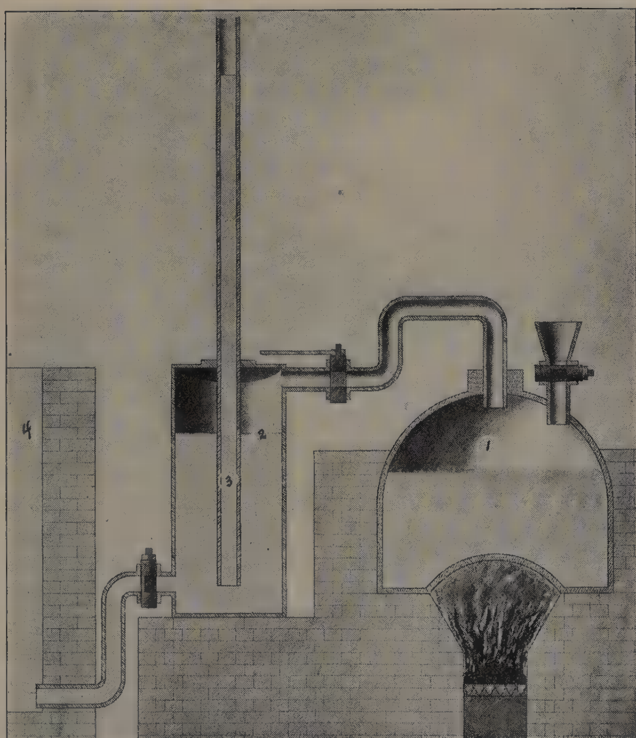
206 From a model in the Deutsches Museum, Munich

STEAM DEVICE OF GIOVANNI BRANCA, 1629

In 1629 an Italian named Branca invented another steam device. He made steam in a vessel shaped like a man's head. The steam issued from a blowpipe in the figure's mouth and struck against the vanes of a wheel, causing it to revolve. The wheel in turn was geared to a shaft which was arranged to lift alternately two pestles for crushing grain in a mortar.

STEAM FOUNTAIN OF THE MARQUIS OF WORCESTER, 1663

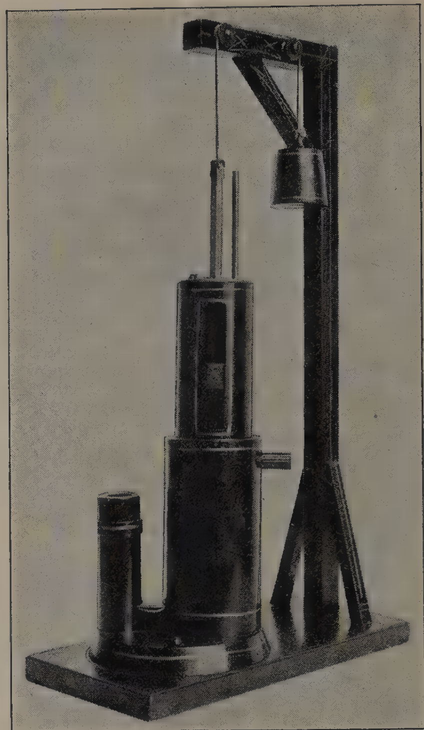
The next use of steam is typified by the engine constructed by Edward Somerset, Marquis of Worcester. Upon the basis of a patent issued to him in 1663, he built, about 1668, and put into successful operation at Raglan Castle, Vauxhall, a steam engine to force a jet of water into the air. Upon the description of an eyewitness a restoration has been made. The machine had four essential parts. One was a boiler (1) where steam was created. From the boiler the steam was carried to the top of a cylinder (2) containing water. The pressure of the steam upon the surface of the water forced the water to escape upwards through a tube (3). The water was maintained in the cylinder from a reservoir (4).



207 From a problematical restoration in the South Kensington Museum, London

DENIS PAPIN'S ATMOSPHERIC STEAM ENGINE, 1690

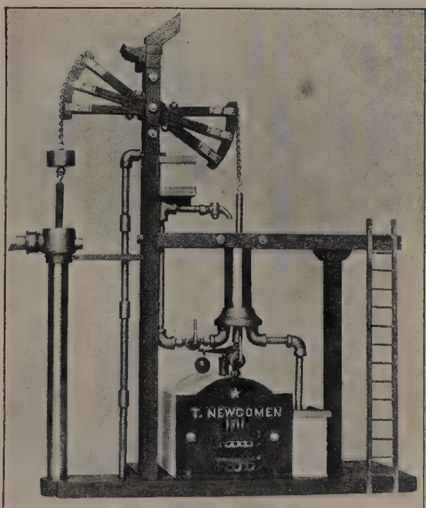
THE engines which first became commercially successful were those operated by means of a cylinder and piston. The germ of this principle had appeared in the experiments of the Marquis of Worcester and also in those of another Englishman by the name of Thomas Savery. But the honor of introducing the first practical steam engine having a cylinder, piston, and even a safety valve, belongs to Denis Papin, a French physicist and doctor, who made many other contributions to the science of physics. Papin in 1690 proposed a thin topped cylinder fitted with a piston provided with a rod on which was a latch. Water in the cylinder was externally heated and steam generated to force the piston upward where in its topmost position it was retained by the latch. When the fire was removed the steam condensed so that the piston fell with such force as to enable it by an attached rope to lift a weight.



208 From a model in the United States National Museum

NEWCOMEN'S ENGINE

THOMAS NEWCOMEN is credited with the invention of the steam engine that started the series of inventions ending with Watt. Newcomen's engine consisted of a steam cylinder and piston actuating a beam from the opposite end of which a pump rod was attached which operated the pumps for lifting water from a mine. Newcomen's original engine was invented in 1705, and was first used for the pumping of mines about 1711.

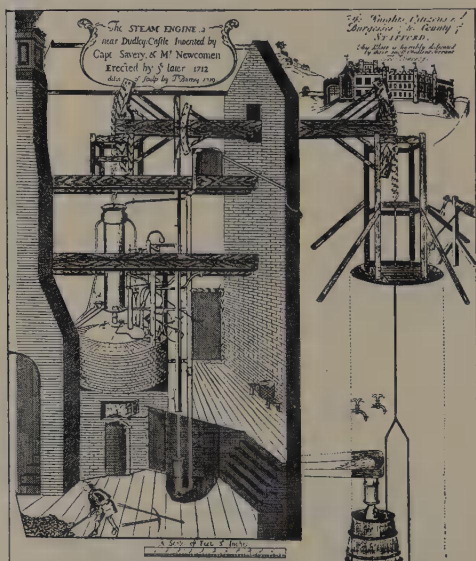


209 From a model by Wilbur Decker, Minneapolis

Newcomen's engine was not actuated by the expansion of steam against the piston, for this was raised by the counterweights of the beam and sucked steam into the cylinder at about atmospheric pressure. When the piston was at its highest point, the steam supply valve was closed and a water valve opened. The water flowed into the cylinder containing the steam which was thereupon condensed. This lowered the pressure by vacuum below that of the atmosphere and caused atmospheric pressure to push the piston down, thus lifting the counterweight and pump rod.

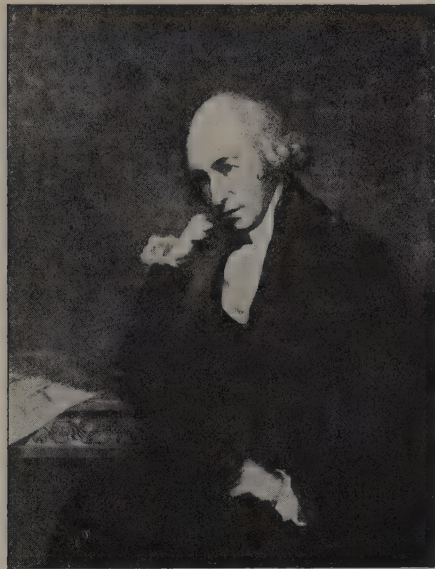
A NEWCOMEN ENGINE, ERECTED IN 1712

NEWCOMEN, with the assistance of John Cawley and Thomas Savery, improved his engine. According to the generally accepted story, a boy, Humphrey Potter, tired of his job of opening and closing the steam and water valves, connected the valve gear with the engine by cords so as to do automatically what he had been paid to do by hand. With this idea incorporated and other improvements suggested by Smeaton and others, Newcomen's engine came into quite general use throughout Europe. The engine shown in this engraving is believed to be the first constructed by Newcomen which contains the self-acting valve gear.



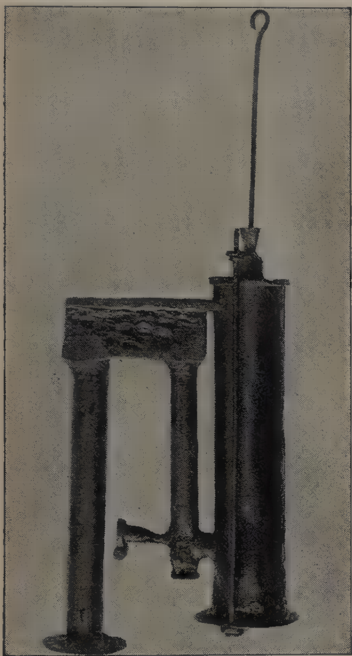
210 From an engraving, 1719, by T. Barney, in the South Kensington Museum

JAMES WATT, 1736–1819, FATHER OF THE STEAM ENGINE



211 From the portrait by Charles Frederick von Breda (1759–1818), in the National Portrait Gallery, London

JAMES WATT, a Scotsman born at Greenoch, January 19, 1736, chose the trade of mathematical instrument maker and spent a year in study for it at London. Returning to Glasgow and setting up in business, he was appointed, in 1757, instrument maker for the University of Glasgow. A model of Newcomen's engine which he was asked to repair started him upon an exhaustive study of the properties of steam, and of the means of producing and controlling it. As a result he so improved Newcomen's engine that he had a vital share in bringing about the Industrial Revolution, and is hailed as the creator of the modern steam engine. He died in England, August 25, 1819, a prosperous, influential and esteemed citizen.



212 From the original experimental model in the South Kensington Museum

WATT'S SEPARATE CONDENSER, 1775

WATT'S first great contribution to steam engineering was his invention of the separate condenser. He saw that the alternate heating and cooling of the Newcomen engine caused an excessive consumption of steam and a slow moving engine. In order that the cylinder should always "be as hot as the steam that entered it" he closed it and provided a separate condensing vessel into which the steam was led after it raised the piston. He installed an air-tight jacket to maintain the heat of the cylinder and added a tight packing in the cylinder head for the piston rod to move through, together with a steam-tight stuffing box on top of the cylinder. Then he alternated the admission and condensation of steam upon both sides of the piston, giving twice the power strokes and increasing the speed of the engine. Watt next devised a crank for changing the reciprocating motion of the piston rod into a rotary motion. In short, most of the essential features of the modern reciprocating steam engine were first established by Watt.

OLD WATT ENGINE ERECTED IN 1776

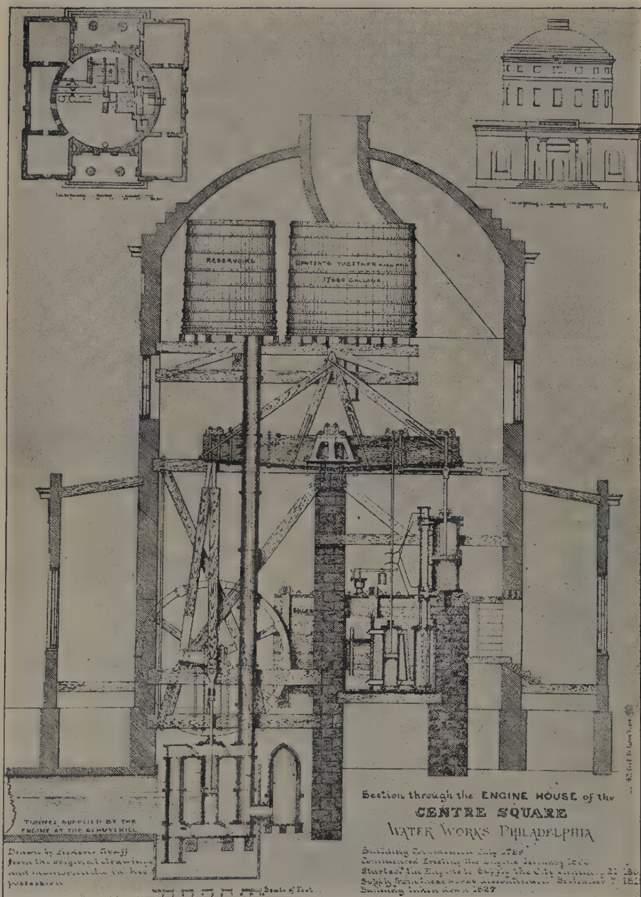
A FAMOUS Watt engine, which at first glance might be mistaken for one of Newcomen's, was built in 1776 and was in service for one hundred and twenty years. In 1898 it was removed to Tipton, where it was reërected and preserved as a memorial of the early days of steam engineering. With such clumsy devices began the development which has resulted in those marvels of inventive skill which furnish so much of the motive power of the twentieth century.

213 Courtesy of W. T. Avery, Ltd., London

CYLINDER OF THE FIRST STEAM ENGINE IN AMERICA

Watt's engine was received with enthusiasm by the world's mechanics and engineers. The first steam engine erected in America was a Watt engine. This engine was imported from England in 1753 by Colonel John Schuyler for the purpose of pumping water from his copper mine opposite Belleville, near Newark, New Jersey. The engine was brought to America by Josiah Hornblower, of a famous family of British engineers, and uncle of Jonathan Hornblower, Jr., who invented the compound engine. Josiah Hornblower probably had something to do with the building of the engine he imported. Finding the American environment agreeable he decided to settle here and for many years he was in charge of the mines at Belleville. During the Revolution, the engine house and mine-works were destroyed by fire but were rebuilt in 1794. Hornblower played an honorable part in the American Revolution and following the war was a member of Congress and later Judge of the Essex County Common Pleas Court. A cylinder is all that is left of the original engine brought over by Hornblower.

214 From the original in the United States National Museum



215 From the original drawing, courtesy of the Bureau of Water, Philadelphia

ENGINE AT THE PHILADELPHIA WATERWORKS, 1800

Progress in steam engine construction in the United States was not rapid. In May, 1803, Benjamin H. Latrobe, the famous American architect, read a paper before the American Philosophical Society at Philadelphia in response to a query as to "whether any, and what improvements have been made in the construction of steam engines in America." According to Latrobe the only engines of any considerable power at that time working in America were the following: At New York there was an engine belonging to the Manhattan Water-power Company to supply the city with water; also one belonging to Nicholas J. Roosevelt to saw timber; at Philadelphia two, city-owned, for supplying water. The drawings for the Philadelphia engines were made by Frederick Graff, who was then the draftsman for the Philadelphia Waterworks. The construction of the first of these engines, that for the Center Square station, was commenced in the year 1800 in Belleville, at the Soho works of Nicholas J. Roosevelt, who had been connected with the Hornblower mine and had even made a copy of the Hornblower engine.

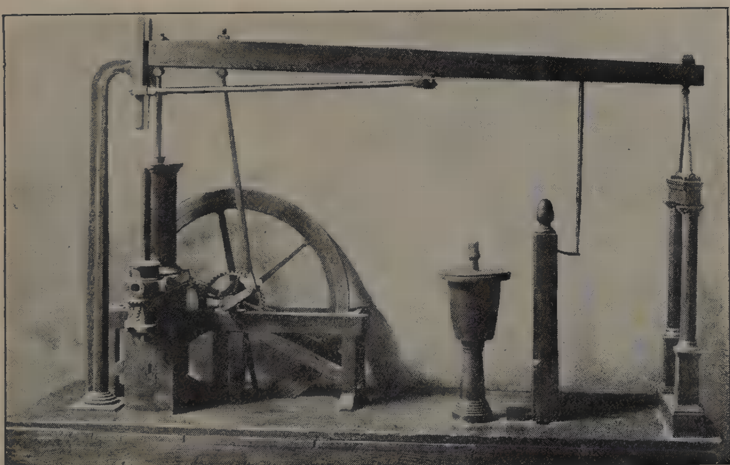
OLIVER EVANS, 1755–1819, THE WATT OF AMERICA

Oliver Evans may be said to be America's first great engineer. In his studies and experiments in the use of water power he invented a series of devices for flour milling which revolutionized that business. In addition he did much to inaugurate modern methods of sawmilling. In the domain of steam he is important as being the first to adopt the high-pressure principle in the construction of steam engines. Evans put his engine to practical use in driving mill machinery.

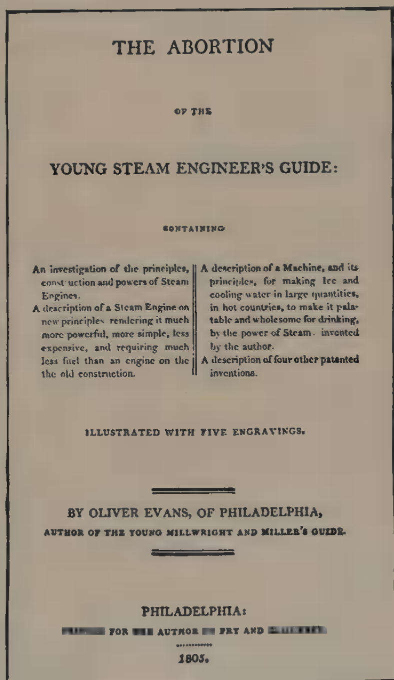
216 From an engraving, about 1848, by W. G. Jackman

AN EVANS ENGINE, 1804

Evans had a plant at Philadelphia where he manufactured steam engines of the type invented by him. From his shop in 1804 came, among others, the "Oruktor Amphibolos," the first steam dredging machine and one of the earliest steam-driven carriages. Evans also used his engine for steamboats, flour milling and sawing marble. In addition to the engine itself he improved the old-style spherical boilers by adding to a horizontal cylinder boiler two longitudinal flues. Evans was to America what Watt had been to Great Britain.



217 From a model in the Franklin Institute, Philadelphia, courtesy of Dr. G. A. Hoadley



THE ABORTION

OF THE

YOUNG STEAM ENGINEER'S GUIDE:

CONTAINING

An investigation of the principles, construction and powers of Steam Engines.

A description of a Steam Engine on new principles rendering it much more powerful, more simple, less expensive, and requiring much less fuel than an engine on the the old construction.

A description of a Machine, and its principles, for making Ice and cooling water in large quantities, in hot countries, to make it palatable and wholesome for drinking, by the power of Steam. invented by the author.

A description of four other patented inventions.

ILLUSTRATED WITH FIVE ENGRAVINGS.

BY OLIVER EVANS, OF PHILADELPHIA,

AUTHOR OF THE YOUNG MILLWRIGHT AND MILLER'S GUIDE.

PHILADELPHIA:

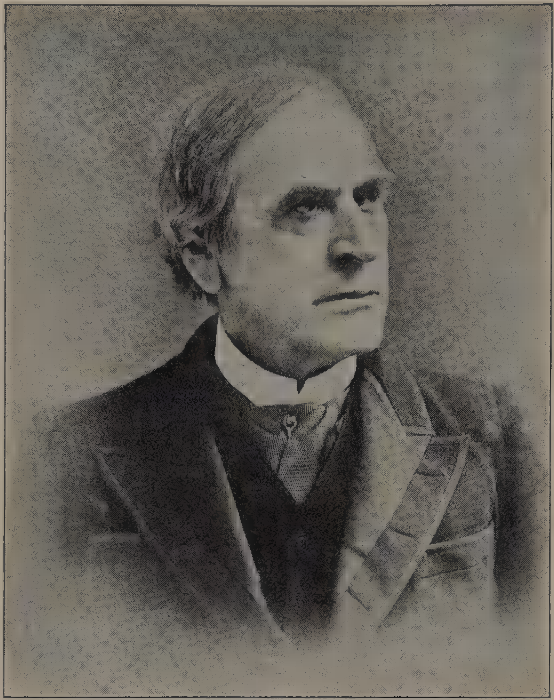
[redacted] FOR [redacted] AUTHOR [redacted] FRY AND [redacted]

1805.

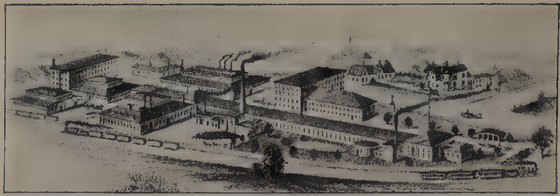
218 Title-page of the first edition, in the Historical Society of Pennsylvania

EVANS' BOOK ON STEAM ENGINES

One of the dreams of Oliver Evans was to write a book on the steam engine in which Americans could get for the first time a thorough description of how engines were constructed and operated. The work as planned was to be called "The Young Engineer's Guide" and was to contain a profusion of drawings and illustrations. While engaged in writing it, he was unexpectedly deprived of his income by a refusal of Congress to extend his patent rights on flour-milling machinery. He was obliged to reduce the scale of his book and "to omit many of the illustrations he had promised." He wrote his bitterness of feeling into the title of the book. It came out in 1805, a thin volume with only five illustrations.



219 George H. Corliss, 1817–88, from a photograph in the possession of Miss Marie L. Corliss, Providence



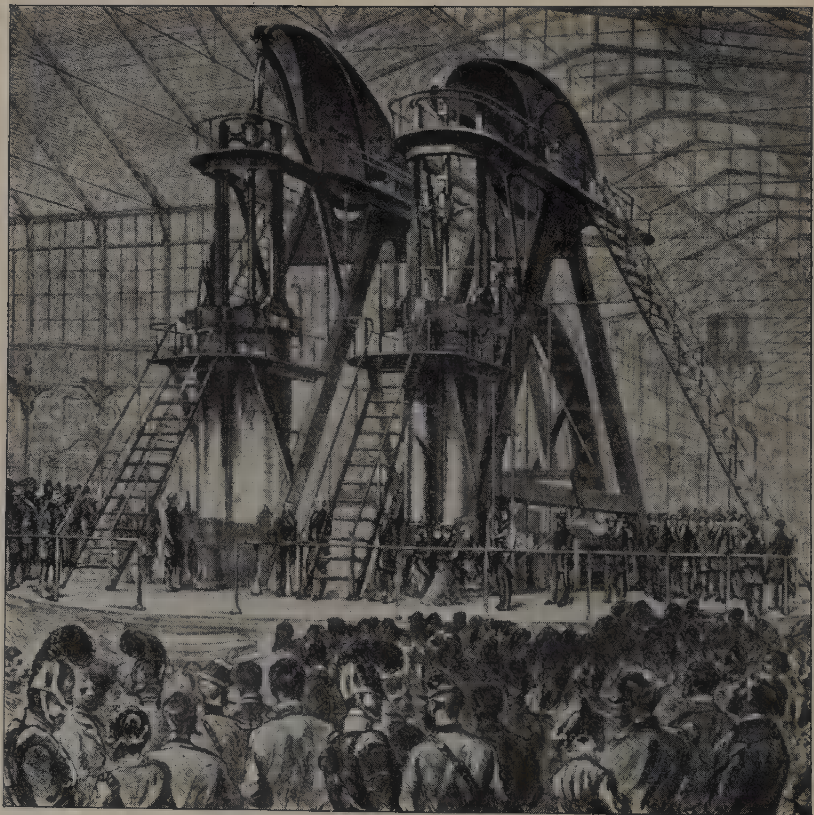
220 Plant of the Corliss Steam Engine Company, Providence, R. I., from an engraving by Van Slyck & Co., Boston

THE CORLISS ENGINE

Watt had devised most of the essential features of the reciprocating engine and later engineers merely perfected and adapted his inventions. Among the most famous of the later engineers was George H. Corliss, inventor of the engine that bears his name and president of the large company that manufactured it. Before the time of Corliss the governor had been directly connected with the throttle valve, but Corliss connected it with the "cut off." He also made some valuable improvements in the valves that permitted the building of very large engines of high efficiency. To sell his engines Corliss offered to take in pay what was saved in fuel for a given time. One buyer paid four thousand dollars on these terms for a relatively small installation. The plant in which Corliss built his engines at Providence, Rhode Island, became in time one of the greatest in the world.

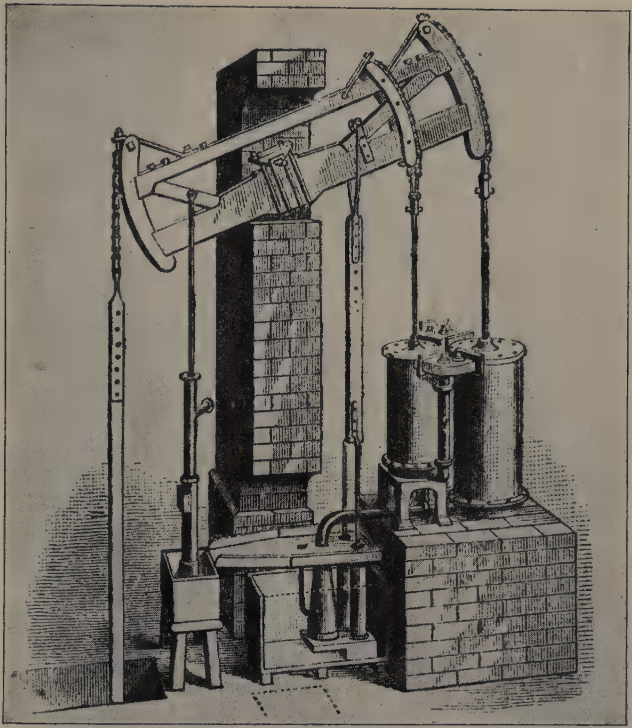
THE CORLISS ENGINE AT THE CENTENNIAL EXPOSITION

The most famous Corliss engine was constructed for the Philadelphia Centennial Exposition in 1876. Corliss spent a hundred thousand dollars of his own, in addition to the money appropriated by the exposition, in constructing this gigantic, seven hundred ton machine. Its fourteen hundred horse power turned the machinery of the exposition. The starting of the Corliss engine was one of the big events of the exposition. In the presence of a brilliant array of notables, the President of the United States and the Emperor of Brazil set the huge machine in operation. The exposition engine was purchased by the Pullman Company and did service in their Chicago plant for more than a generation.



221 From *Harper's Weekly*, May 27, 1876, after a drawing by Theodore R. Davis

HORNBLOWER'S COMPOUND ENGINE, 1781



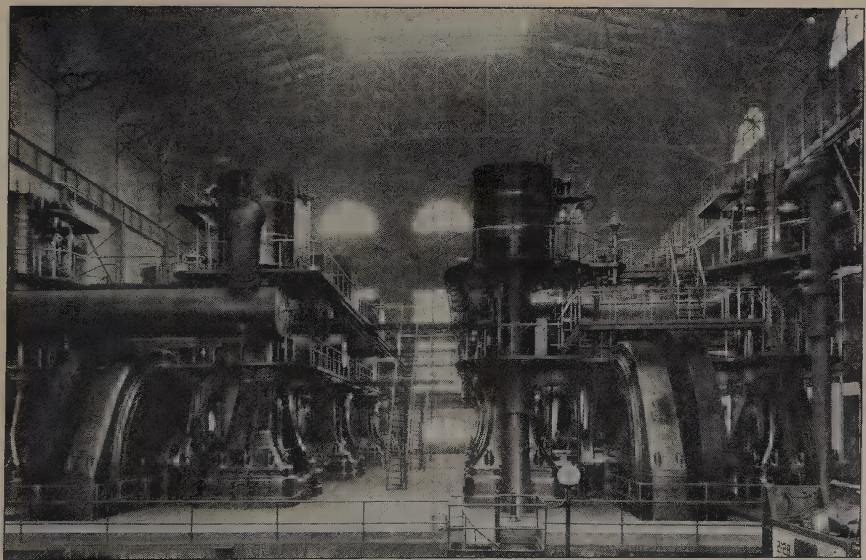
222 From Robert H. Thurston, *A History of the Growth of the Steam-Engine*, New York, 1878

SINCE the time of Watt, engineers have endeavored to extract every bit of the expansive power of steam by using the waste steam from one cylinder to drive the piston in another. Thus in Watt's own time, Hornblower, Woolf and Faulk, and later Sims and McNaught succeeded with compound engines. Kirk, about 1874, carried the improvement a step farther by introducing the triple expansion engine, and about 1890, with increased steam pressures, the quadruple expansion engine became common. Adamson and Cowper were prominent among the engineers who popularized the quadruple engine. Hornblower's idea was to admit steam at high pressure into a small cylinder where in expanding it moved a piston. The steam was then admitted to a large cylinder where in completing its expansion it moved another piston. The same steam was thus made to do twice the work done by a one cylinder engine.

These multiple expansion engines were not only economical of steam and heat but gave the engine a steadier motion, and reduced the maximum load upon the working parts by the reduction of the range of pressure in each cylinder, with consequent reduction of weight in construction.

A MODERN STEAM ENGINE

THE progress of the stationary steam engine has been connected most intimately with the expansion of manufacturing industry in America. Great enterprises require equally great power resources. Inasmuch as fifty-eight per cent of the power for all manufacturing is obtained from steam, it follows that the steam engine paces manufacturing. The typical modern steam engine is one of mammoth size, capable of producing enormous power. It is most frequently seen in those states that combine large manufacturing interests with nearness to great coal resources.



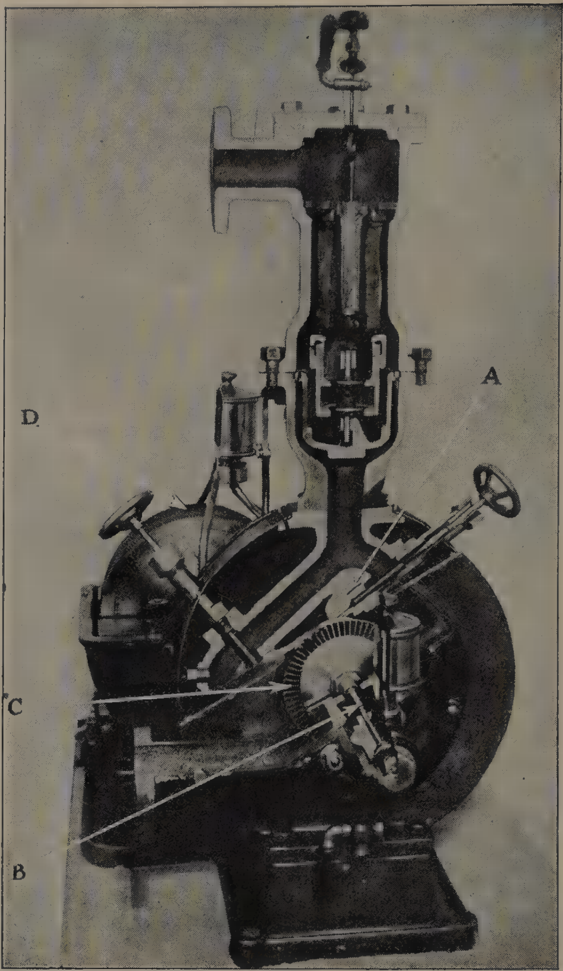
223 Courtesy of the New York Edison Company

Although the steam engine produces much of the power used in manufacturing, it has become the prevailing habit to convert this power into electricity for transmission about a plant and employ it with separate motors. As a result the completely typical modern steam engine is not only a large one, but one directly connected with a dynamo.

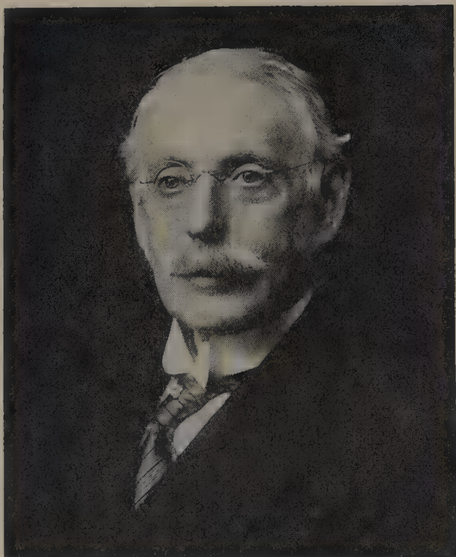
THE DE LAVAL STEAM TURBINE, 1889

In ordinary engines the push of the steam as it expands is exerted against a piston, producing a motion forward and back. Such engines are called *reciprocal.* A special type, known as the steam turbine, employs not the expansive power of steam, but rather its *speed* or the kick as it issues from an opening. Later turbines were arranged to take advantage of the expansive power of steam as well. Turbines have a *rotary* rather than a reciprocal motion. As reciprocating engines were built larger, the costs of installation and operation mounted. The space they occupied and the weight of the machine also increased with their size. The turbine has the advantages of being smaller, more compact, simpler, faster, and more economical because it has but one moving part to perform every essential office. Turbines also can be added to reciprocating outfits to run on exhaust steam. They are capable, too, of being directly connected with dynamos or other machinery.

The first modern designer of steam turbines was Gustaf de Laval. The design of the original de Laval turbine was completed in 1889. The essential features were the nozzles (A) in which the steam expanded, the slender shaft (B) on which the wheel (C) was mounted (one inch for 100 horse power), the wheel (C) or disk with suitable blades, and the reducing gears (D) by means of which the high speed of the turbine shaft was lowered to be available for driving machinery. The large size of the gear wheels as compared to the turbine wheel itself is noteworthy. A nineteen-inch de Laval wheel is capable of developing 100 horse power, and if unregulated may whirl with sufficient speed to tear off its own rim.



224 From a model in the Deutsches Museum, Munich

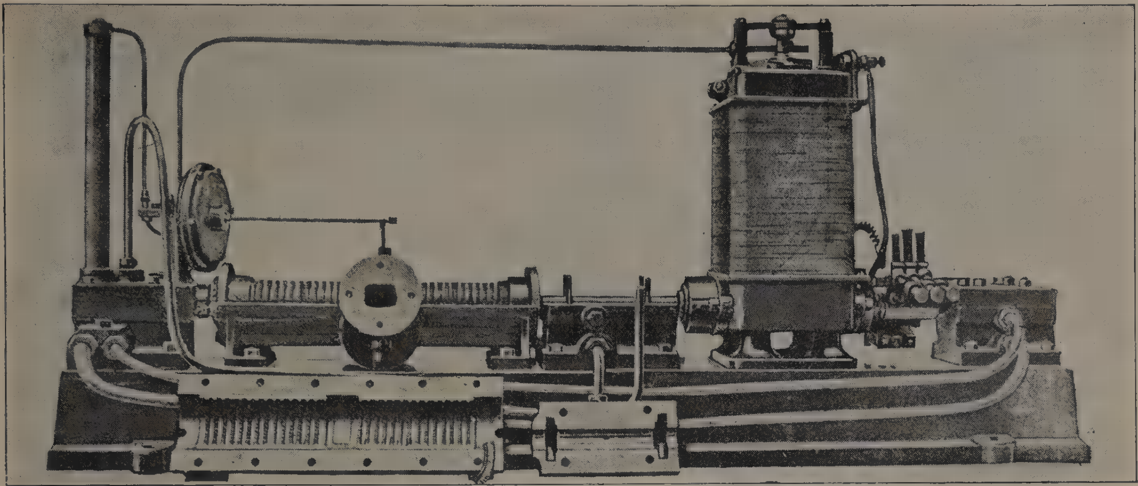


225 Courtesy of C. A. Parsons Company, Ltd., Newcastle, England

SIR CHARLES A. PARSONS, 1854–, INVENTOR OF THE COMPOUND STEAM TURBINE

After de Laval the most important early developer of the steam turbine was Sir Charles Algernon Parsons, the fourth son of William Parsons, Earl of Rosse. Sir Charles not only invented the compound steam turbine that bears his name but also a condenser for this engine. Later he adapted his engine for marine use, which started an array of experiments and machines for reducing the space required for the motive power of ships. The first Parsons marine turbine was installed in the British ship *Turbinia.* In 1912 Parsons devised the geared turbine.

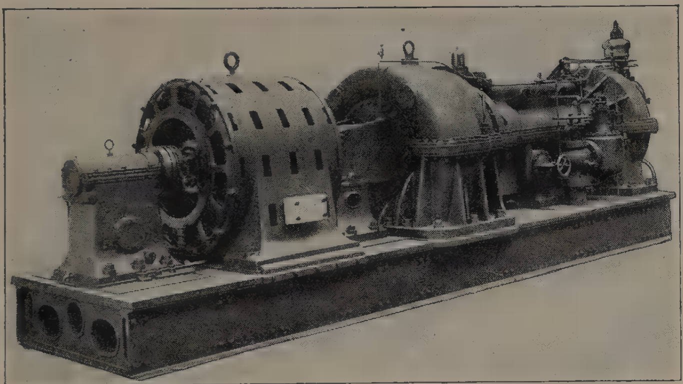
Sir Charles is not only an engineer with an inventive mind, but is the executive head of the C. A. Parsons Company, an engineering and electrical manufacturing company. In addition he is the presiding officer of the Parsons Marine Steam Turbine Company and an executive in two electrical supply companies. His book *The Steam Turbine* was for a long time the standard authority in its field.



226 Parsons' First Successful Turbine, 1884, from the original in the South Kensington Museum

THE PARSONS TURBINE

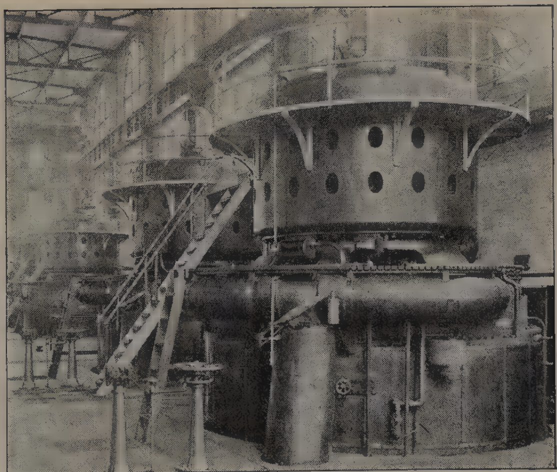
THE Parsons turbine, built first in 1884, differed from de Laval's in having stationary vanes instead of nozzles, so shaped as to direct steam upon moving blades just as nozzles would. Many rows of moving blades were attached to the cylindrical surface of a revolving drum called a rotor. Furthermore, the de Laval turbine made no provision for the expansion of the steam in the moving blades while the Parsons machine gave as much expansion in the moving blades as in the stationary vanes. The Parsons turbine, then, was somewhat like a series of separate wheels all attached to one shaft. These wheels, varying in size, operated under the successively lowered pressures of the steam as it varied from admission to exhaustion. A similar effect was gained in the later de Laval turbines only by constructing them on the multiple stage principle.



227 Parsons Turbine of American Manufacture, courtesy of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

CURTIS STEAM TURBINES OF EARLY TYPE

THE Curtis steam turbine, patented by C. G. Curtis in 1895, uses nozzles for expanding steam before the latter reaches the wheel buckets, thus resembling the de Laval turbine. The complete expansion from boiler to exhaust pressure, however, is completed by a series of stages as the steam passes through a succession of chambers. Each chamber is separated from the others by diaphragms. Each chamber contains one bucket wheel, but all are the same size, differing from the Parsons multiple stage arrangement wherein the blade wheels taper from small to large sizes. The Curtis turbines are made with power capacities ranging from 20 horse power to about 12,000 horse power.



228 Courtesy of the General Electric Company

CHAPTER VI

TAPPING THE OIL POOLS

THE need which first made petroleum significant was that of illumination. For many centuries candles and wicks in vegetable oils had been the chief modes of lighting. The settlers in colonial America had brought the art of candle making from the homeland. In the early primitive days of the colonies almost every household had supplied itself with this indispensable article. Later professional chandlers had appeared. But candles were not the only method of lighting.

Before the seventeenth century had passed the whale fishery had begun along the coast of what was destined to be the United States. In the eighteenth century ships were pushing out from whaling centers such as Nantucket and were scouring the broad ocean for the valuable and plentiful prey. In the first half of the nineteenth century, after the fighting of the War of 1812 had ceased, whaling increased at a tremendous rate. The square sails of American whale ships became familiar sights on the Pacific and Arctic oceans as well as on the Atlantic. The whales were yet plentiful, and the industry grew until it reached its peak in the eighteen 'forties and 'fifties. Whaling was profitable because whale oil could be turned into a useful illuminant, although the business acquired several other saleable by-products. Then the day of the whaler suddenly passed when a cheaper and better illuminant was developed from petroleum.

Through many ages of geologic history pools of oil have lain beneath the surface, confined above and below by rock strata through which the liquid could not pass. From time immemorial in America Indians and later the white men who came to exploit the continent observed petroleum seeping out at the surface through crevices in the rocks or bubbling up in streams and pools. Not until the science of chemistry was well advanced was it realized that wealth lay far below the oily surface of the pools.

The dramatic story of petroleum begins with the drilling of Drake's well in a wild part of Pennsylvania in 1859. Picturesque, bizarre, pathetic, romantic and humdrum features are all to be found in the story of oil. Oil has not displaced coal as the driving power of the modern industrial world, but oil is to-day one of the great prizes for which nation contends with nation. The possession of its waning stores spells power.

Not as an illuminant, however, but as a source of fuel for the internal combustion engine has petroleum come to play its great rôle in civilized life. Gasoline and the gas engine have made possible the automobile, revolutionizing modern life, and leading to the conquest of the air, with potentialities still undreamed of.

229 From the motion picture *The World Struggle for Oil*, produced under direction of the Bureau of Mines, Sinclair Consolidated Oil Corporation coöperating. © 1922, E. F. Butler

INDIANS SKIMMING OIL FROM A CREEK

Knowledge of petroleum is older than history. The Persians knew the oil fields near the Caspian Sea, and being fire worshipers, they erected temples over the flames issuing perpetually from the earth. The Indians of America also knew petroleum long before white men discovered the continent; they used it as a medicine, even internally. They collected the oil by skimming surface pools, or by dipping their blankets and wringing the oil into bowls. Since the action of the oil upon the body was more or less mysterious to the Indians, the places where oil was found were held in esteem approaching that felt for sacred ground.

230 From Peter Kalm, *Travels into North America*, London, 1771

EARLY MENTION OF OIL IN AMERICA

The earliest mention of the existence of petroleum in the New World occurs in Sir Walter Raleigh's account of the Trinidad pitch lake, written in 1595. Thirty-seven years later the account of a visit of the Franciscan father, Joseph de la Roche d'Allion, to the oil springs of western New York, was published in Sagard's *Histoire du Canada*. In 1748 Peter Kalm in his *Travels into North America* indicated on a map the oil springs of western Pennsylvania.

A "QUACK" SELLING SENECA OIL

The Indians taught the whites the medicinal qualities of petroleum, and in the late eighteenth and early nineteenth centuries it was sold in drug stores or by itinerant vendors. Usually an Indian name was given to the oil, and it was advertised as an Indian remedy. The most common name was that of "Seneca Oil." This "Seneca Oil" had the same standing among the whites as other well-known Indian remedies such as Snake Oil, Skunk Oil, and Bear's Grease.

231 From the motion picture *The World Struggle for Oil*. © E. F. Butler

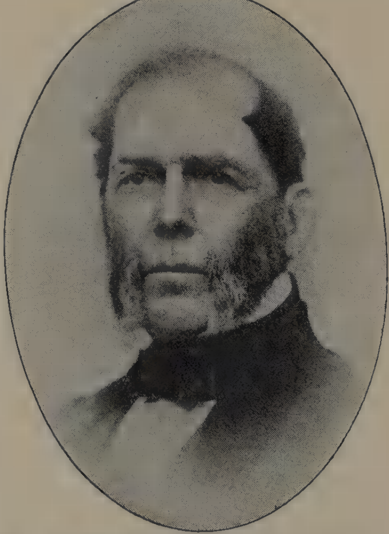
232 From J. T. Henry, *The Earlier and Later History of Petroleum*, Philadelphia, 1873

KIER COMMERCIALIZES PETROLEUM

The most significant commercialization of petroleum as medicine was that of Samuel M. Kier, a Pittsburgh druggist, about the year 1848. Failing in this venture, he turned to the exploitation of oil for industrial purposes. The above label was used by Kier in his advertising campaign to introduce petroleum as a medicine.

PETROLEUM AS AN ILLUMINANT

Prior to Kier's experiment with petroleum as a medicine, a new illuminant had appeared on the Atlantic coast imported from the Canadian provinces by Abraham Gesner, who gave it the name of "kerosene." This kerosene distilled from shale oil impressed Kier with its similarity in taste and smell to his petroleum medicine, so he scrapped his medicine campaign and sold his petroleum as a rival illuminant to kerosene. About the same time another American, Colonel A. C. Ferris, attempted to popularize petroleum as an illuminant. Kerosene was a great improvement on either candles or whale oil. As lamps for burning it were perfected it made rapid progress in displacing the older methods of lighting. The more progressive homes of America were equipped with the new oil lamps.



233 Abraham Gesner, 1797–1864, from a photograph in the possession of the Rev. A. T. Gesner, Waterbury, Conn.

234 From a contemporary photograph taken by John A. Mather

THE FIRST OIL WELL

THE success in selling a petroleum illuminant attracted the attention of capitalists in New York and New Haven. They organized a company to procure, manufacture, and sell petroleum illuminant and sent "Colonel" Drake, a conductor on the New Haven Railroad, to western Pennsylvania to discover oil. Kier had never drilled for oil, but his medicine bottles had a label showing a salt-well rig. Seeing this fanciful picture, the New Haven capitalists instructed Drake to go to the neighborhood of Kier's shallow surface oil pools and *drill* for oil as if for artesian water. A derrick was erected in the neighborhood of Titusville, Pa., and in the year 1859 the boring for oil began. In the photograph, Drake, wearing a silk hat, appears talking to his friend Peter Wilson, a druggist of Titusville. In the background are William Smith, Jr., and James Smith, sons of William Smith, a salt-well digger. The father and sons did the actual drilling of the well.

DRILLING THE DRAKE WELL

AFTER weeks of the most arduous work and of heart-rending disappointments, on August 27, 1859, at a depth of sixty-nine and one half feet, Drake at last "struck oil." The oil rose in the well to within a few feet of the surface. A pump and tanks were secured, and every day except Sunday the well was made to yield from twenty to thirty barrels.

235 From the motion picture *The World Struggle for Oil*. © E. F. Butler

CROWD VIEWING DRAKE'S WELL

Upon the news of Drake's success he was instantly transformed from a fool to a hero. The countryside flocked to the well to see with its own eyes the substance behind the great tidings it had heard. Men then hastened home either to plan to win fortunes from their own ground, or to give up their occupations in the village in order to be free to seek sudden wealth by means of the new liquid gold.

236 From the motion picture *The World Struggle for Oil.* © E. F. Butler

237 From *Frank Leslie's Illustrated Newspaper*, Jan. 7, 1865, after a drawing by F. H. Schell

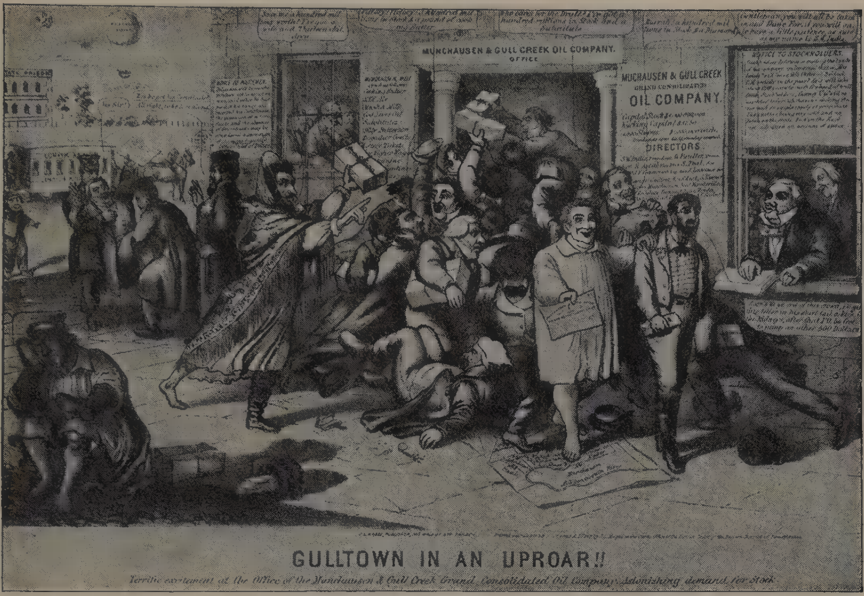
THE RUSH TO OIL CREEK

But the countryside was not the only recipient of the good news. The discovery flashed over the nation. An immediate response came from all classes, from poor clerks and town retailers, from underpaid preachers and teachers, from country editors and city laborers. Grubbing toilers and failures everywhere were filled with a new hope. Scores of them threw up their jobs, sold their businesses, broke up their homes, and with frantic haste swarmed to the spot where wealth awaited only a tapping of the earth. Hardy adventurers and lovers of chance were here also, just as they had been in California some years before and just as they were soon to be in Alaska and the diamond mines of South Africa. Large numbers scattered over land known to contain oil. Fields became towns overnight, and towns became cities within a week. Gamblers and crooks of every description soon followed and gave a flavor to life which greatly resembled that of the gold camps.

238 From *Frank Leslie's Illustrated Newspaper*, Jan. 21, 1865, after a drawing by F. H. Schell

OIL CREEK VALLEY IN 1865

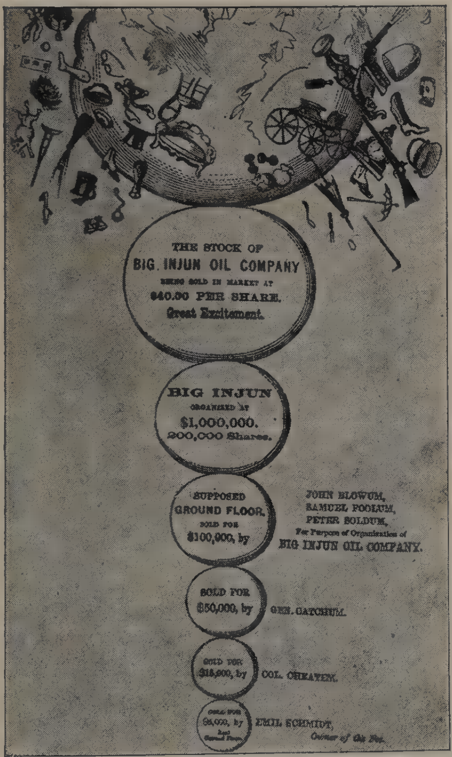
Before 1859 the neighborhood of Oil Creek, Pennsylvania, had been a remote lumbering region sprinkled with roughly cleared farms that yielded a living only by unremitting toil. In a flash this region became the center of intense life and was besieged by new, thronging multitudes. Farms that had been valued at ten dollars a square mile were bartered at hundreds of dollars a square inch. The price was not for the land but for the privilege of drilling for possible oil underneath. Many local people who had seldom seen as much as ten dollars at once had riches poured into their laps by the sale of their lands.



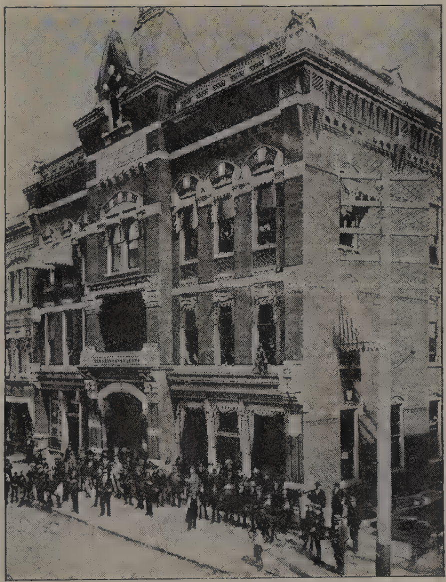
239 From a cartoon, 1865, in the collection of the Historical Society of Pennsylvania, Philadelphia

SPECULATION IN OIL STOCKS

WITH legitimate enterprises enjoying quick and enormous profits, the way of the stock swindler was made easy. There are always men and women in plenty who will part with their savings in return for a promise of instant riches. Cupidity and gullibility were inflamed by authentic accounts of sudden fortunes made in the oil fields. Oil companies were promoted, some the result of a sincere hope that the land which the company had leased would prove rich in oil, others the fabrications of human vultures seeking profits from an ignorant and unsophisticated public. Beautifully engraved certificates of oil stocks were distributed even in remote parts of the country. As the companies developed, the prospectus all too frequently mingled exaggerated optimism with deliberate misstatement.



240 An Oil Swindle, from S. P. Irvin, *The Oil Bubble*, Franklin, Pa., 1868



241 From a contemporary photograph in possession of W. H. Hunt, Narberth, Pa.

THE OIL EXCHANGE AT TITUSVILLE

WITH constant trading in leases and oil company stocks, there was a need in the oil regions for an organized method of conducting business at a centralized place. A stock exchange appeared in Titusville where thousands of dollars worth of securities were traded; here the oil fever burned its hottest; here magic fortunes were magically made — and lost.

242 From a photograph by Gruber, Oil City, Pa.

THE VANISHED GLORIES OF PITHOLE CITY

The oil fever burns too hotly to endure. When the first excitement has died out every field settles down to the humdrum of drilling, pumping and storing oil. Sooner or later every oil well runs dry and the current of prospecting moves on to more fertile regions. Pithole City in 1859 was a field of waving grain. During the 'sixties it blossomed into a boom city and its post office receipts were second only to those of Philadelphia. To-day Pithole City has vanished and in its place the quiet life of the farm again holds sway.

243 From a photograph by Gruber, Oil City, Pa.

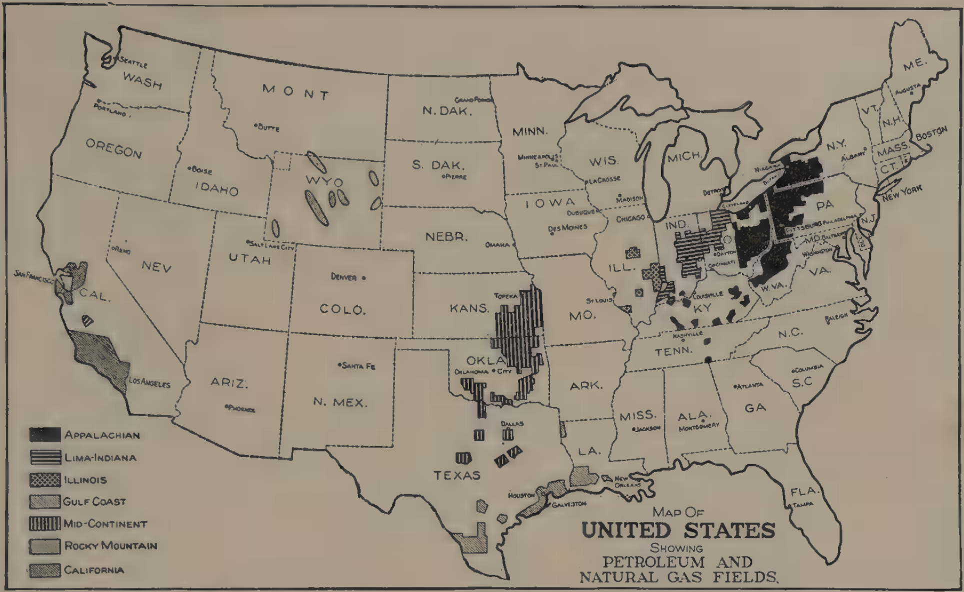
DRAKE MONUMENT, TITUSVILLE

But even the wealth and fame that were legitimately won in the oil boom towns were too often as swiftly lost. Drake himself, the first to strike oil, soon dissipated his winnings and he and his family were reduced to actual want. They were facing starvation when a tardy sense of gratitude caused the state of Pennsylvania to grant the Drakes an annuity of $1500 a year. Years afterward a monument to the memory of Drake was erected near his first well on the outskirts of Titusville. A pension and a monument were all Drake got for his gift of petroleum to the world.

A BOOM OIL TOWN, TEXAS

From Pennsylvania the oil industry swept across the continent. In the 'eighties Ohio and West Virginia experienced booms similar to that of the Oil Creek regions. To-day the center of the industry is in the West and Southwest, in California, Texas and Oklahoma. Every new oil discovery has been followed by scenes similar to those of Oil Creek.

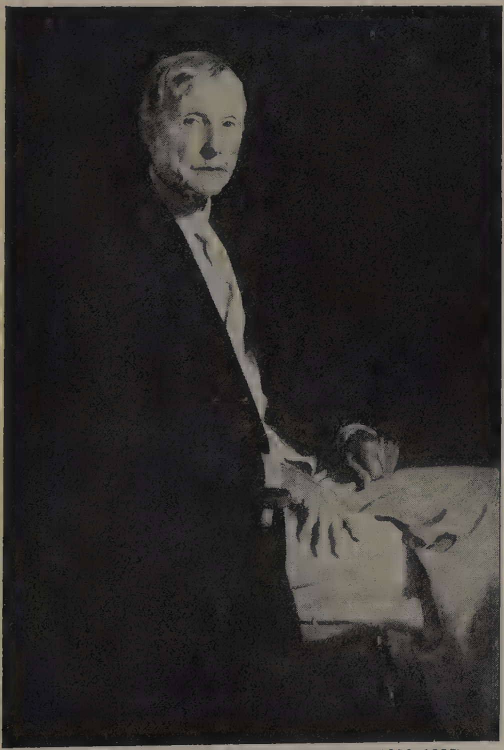
244 From a photograph by A. Abbott, courtesy of the *Oil Trade Journal*, New York



245 From Frank G. Baum, *Atlas of U.S.A. Electric Power Industry*, San Francisco, 1923

THE UNITED STATES AS AN OIL PRODUCER

No map of the principal oil-producing areas in the United States is permanent because of the decline of oil regions and the discovery of new ones. Although none of our oil regions has as yet been completely exhausted, the output from each has varied greatly from time to time. Consequently, leadership in production has passed from one area to another. At present California is the greatest producer, with Oklahoma pressing close for first honors.

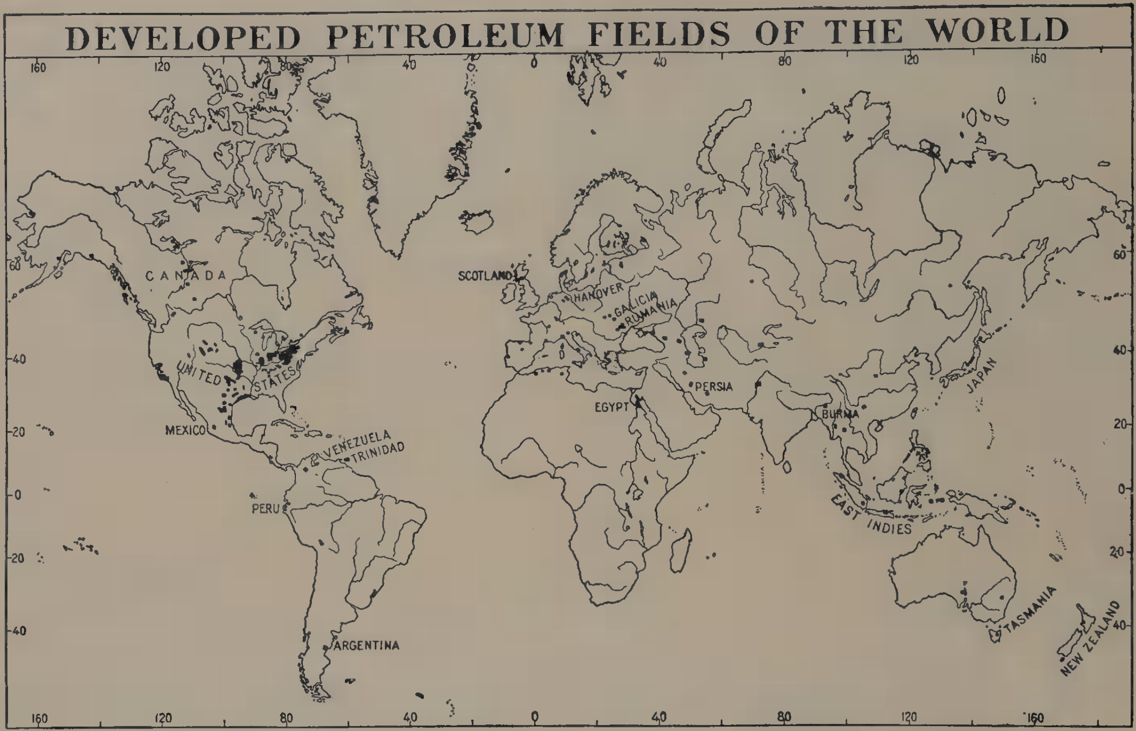


246 From the portrait by John Singer Sargent (1856–1925)

JOHN D. ROCKEFELLER, 1839–, CREATOR OF THE OIL TRUST

THE greatest name associated with the American oil industry is that of John D. Rockefeller. Educated in the public schools of Cleveland, he entered the employ of a mercantile house in that city as a clerk. Promotions made him first a cashier and then a bookkeeper. His first venture into business for himself was in the firm of Clark and Rockefeller in 1858. Two years later he began his long career in the oil industry as a partner in the firm of Andrews, Clark and Company. In 1865 the new firm of William Rockefeller and Company built the Standard Oil plant at Cleveland. Five years later the Standard Oil Company was incorporated with John D. Rockefeller as president. By 1881 the company's business had so ramified and Rockefeller's separate interests in the oil industry had become so great that the whole was formed into the Standard Oil Trust. Although this the courts attempted to dissolve in 1892 and again in 1911, the various Standard Oil units have always acted together and not only dominate the American oil industry but divide with certain British and Dutch interests the oil business of the whole world.

In his later years the elder Mr. Rockefeller and other members of his family have been noted for their great benefactions. Universities, colleges, religious organizations and research foundations have benefited to the extent of many millions from the Rockefeller fortunes.



247 Drawn expressly for *The Pageant of America* by Gregor Noetzel, American Geographical Society, New York

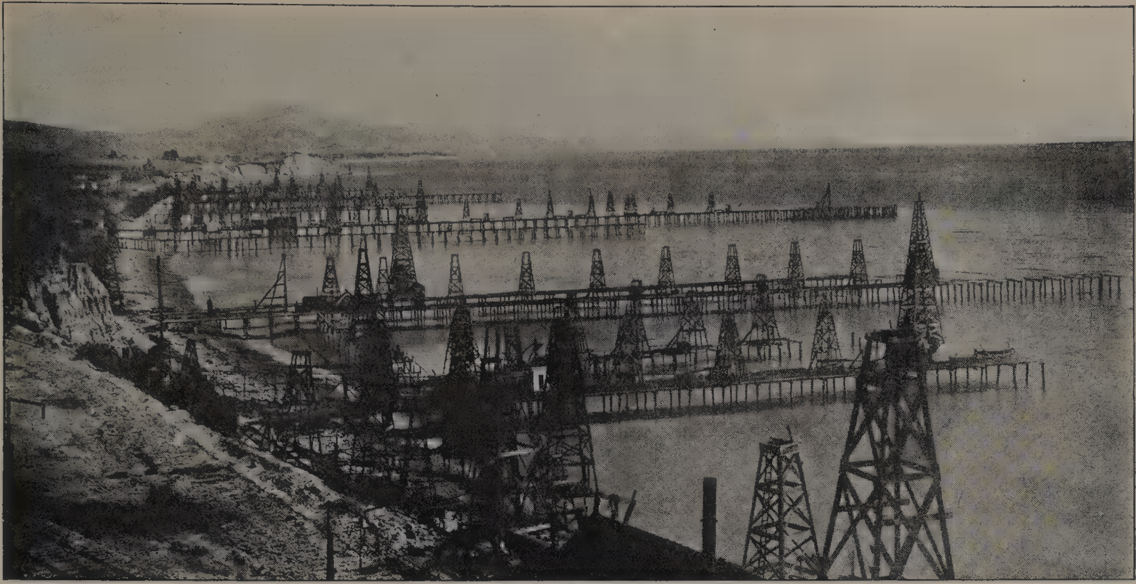
PETROLEUM AND WORLD POWER

American capital — largely in the control of the Standard Oil Company — dominates the petroleum industry of the western hemisphere, while British or British Dutch interests are supreme in the eastern hemisphere, principally through the Anglo-Persian Oil Company and the Royal Dutch Shell Syndicate. Just as nations have sought control of coal areas of the world by commercial strategy, diplomatic negotiations and conquest, so they are now practicing the same arts to gain sway over the known and potential petroleum supplies of the world. It is supposed that industrial, naval, and aërial supremacy in the future depends upon petroleum. In such attempts of nations to dominate the world's petroleum resources lie the seeds of future wars.

OCCURRENCE OF OIL AND NATURAL GAS

No one really knows the origin of oil. Some chemists maintain that it is a fortuitous meeting of the proper chemical constituents within the earth. Most geologists assert that it arose from distillates of plant remains inside the earth, although some hold the theory that it originated from buried fish remains. Whatever its origin we know the manner of its usual occurrence in the ground. Generally it is discovered in pervious rock that is capped with impervious rock. It seems to collect where the pervious rock is folded. Pressure is given to it by its own contained gas and also by water. The degree of pressure determines what kind of a well is obtained when the drilling penetrates through the impervious rock to the pervious rock or "sands." If the pressure is great the oil and gas gush to the surface and may shoot high into the air. Lower pressures produce flowing wells wherein the oil and gas float to the surface. When the pressure is slight the oil and gas must be pumped.

248 From an exhibit in the United States National Museum



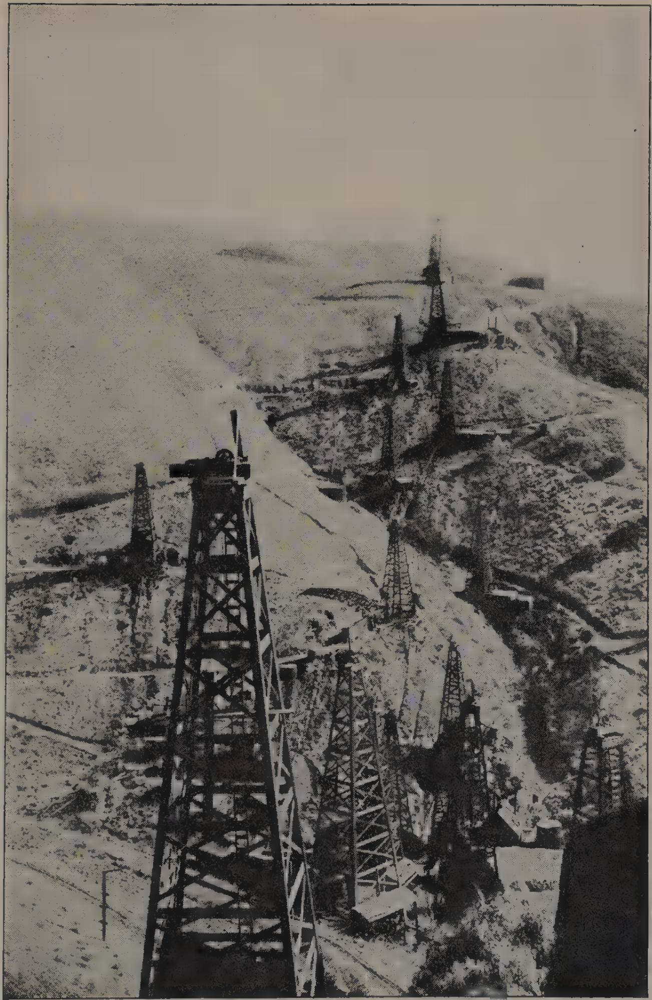
249 From a photograph by the United States Geological Survey

OIL WELLS IN THE PACIFIC

Oil has been discovered and wells bored in forests, on the plains, on deserts, and even under the waters of the ocean. This last offers no greater difficulties than a well on land because the oil is conducted, from the sands deep within the earth to the surface by means of a pipe, as easily through water as through rock.

WELLS ALONG A PROPERTY LINE

The manner of occurrence of oil explains the customary oil field scene where derricks are crowded together sometimes as closely as they will stand. Since oil will flow through the sands to any point where the pressure is released, it follows that the source of oil need not be the sands directly beneath the derrick. The latter, therefore, are often placed on the edge of the property line to gather as much as possible of the neighbor's oil. A single derrick does not require much room and property in an oil field is very valuable per inch. Likewise it does not pay to stop the flow of oil, for what one well forgoes another steals. In consequence a new field is always widely exploited, and excessively wasteful quantities of oil are taken from the ground. This wastefulness in taking oil from the ground is one of the important reasons for the swift depletion of the nation's oil resources.

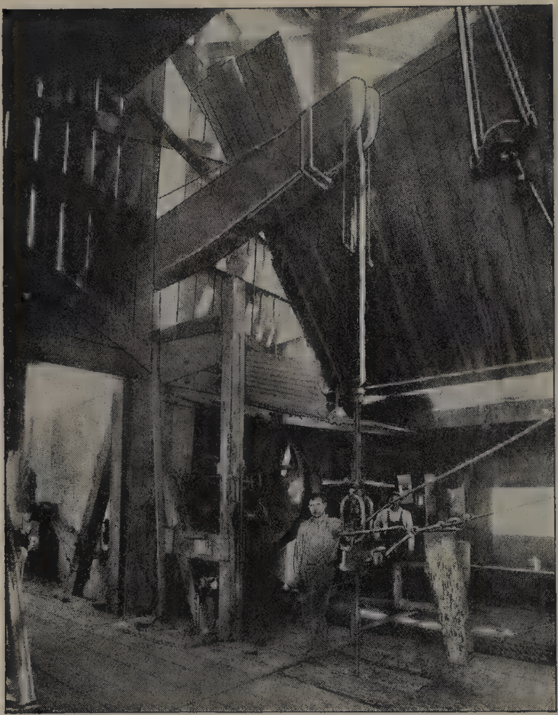


250 From a photograph by the United States Geological Survey

INTERIOR OF AN OLD-TIME DERRICK

The derrick, so picturesque a feature of the oil fields, is merely a device for raising and lowering the string of drilling tools. The length of the tool string determines the necessary height of the derrick. After the drilling is finished the derrick has practically no useful function. In the method of drilling used by Drake and his contemporaries the "walking beam," entering the derrick through a slit, was attached outside to a steam engine which furnished the power. The beam gave the up and down motion to the string of tools which did the drilling.

251 From *Frank Leslie's Illustrated Newspaper*, Jan. 21, 1865, after a drawing by F. H. Schell



252 Courtesy of the Oil Well Supply Company, Pittsburgh, Pa.

INTERIOR OF A MODERN DERRICK

Modern drilling machinery, although a great advance over that of Drake, resembles the early machinery in many respects, particularly in the use of the walking beam.

KICKING A WELL WITH A POLE

Although science has been called upon to aid in locating oil wells no method has yet been devised by which a well can be drilled with certainty of striking oil. All oil prospecting is therefore "wildcatting;" that is, drilling upon a gamble. This makes the task one for individuals generally rather than for great companies. On account of the expense of an ordinary drilling outfit poor prospectors have always resorted to crude and cheap methods. One of the oldest is that of "kicking a well down." For this process a long springy pole is properly balanced and its butt secured. Ropes are fastened to the top with loops at the end. The string of drilling tools is also fastened to the end of the tree. Then a man puts a foot into the loop and kicks downward. This causes the drill to descend. With the release of the pressure from the foot the natural spring of the pole raises the looped rope again and also the string of tools. Wells to a depth of 600 feet have been drilled in this manner. But such crude methods are not common. The typical oil field is a forest of derricks monotonously alike, each with a shed beside it where an engine drives the great walking beam.

253 From the motion picture *The World Struggle for Oil*. © E. F. Butler

254 From a photograph by Krupsick, Tulsa, Oklahoma, courtesy of the *Oil Trade Journal*

"WILDCAT" OIL PROSPECTING

In a somewhat more advanced but still crude and cheap method a steam boiler and engine replace foot power. The rotary motion of the engine flywheel is translated into an up and down motion by the walking beam, to which the string of tools is attached. This device is used only for relatively shallow wells which do not exceed six hundred feet. Such a simple contrivance may be the means of tapping a rich and hitherto unsuspected pool. If oil is not discovered, the expenditure has been slight.

THE ROTARY OIL DRILL

Although most drilling is done by the intermittent up and down motions of the tool string, some rocks and sand permit a continuous rotary drilling process. There are few such cases in America but the method is common in the Baku district of Russia.

255 Courtesy of the Oil Well Supply Company, Pittsburgh

THE BIT THAT DOES THE DRILLING

Regardless of the method employed for boring — reciprocal or rotary motion — the business end of the string of tools is the bit at the lowest tip.

256 From a photograph by F. Gallen, Houston, Texas, courtesy of the *Oil Trade Journal*

257 Courtesy of the Sinclair Consolidated Oil Corporation, New York

A DRILLING CREW

Oil drilling is an occupation in which success generally befalls the hardy and adventurous.

A GUSHER

Sometimes when the oil stratum is penetrated the release of pressure is so great that the oil and gas discharge violently, at times shooting beyond the top of the derrick and even destroying the derrick itself. Occasionally the force has defied man's control and the oil has rushed out for weeks unchecked. Not all of this oil is lost, for earth dikes are built to confine it, but inevitably the loss is heavy. A gusher that can be controlled, however, saves the cost of pumping.

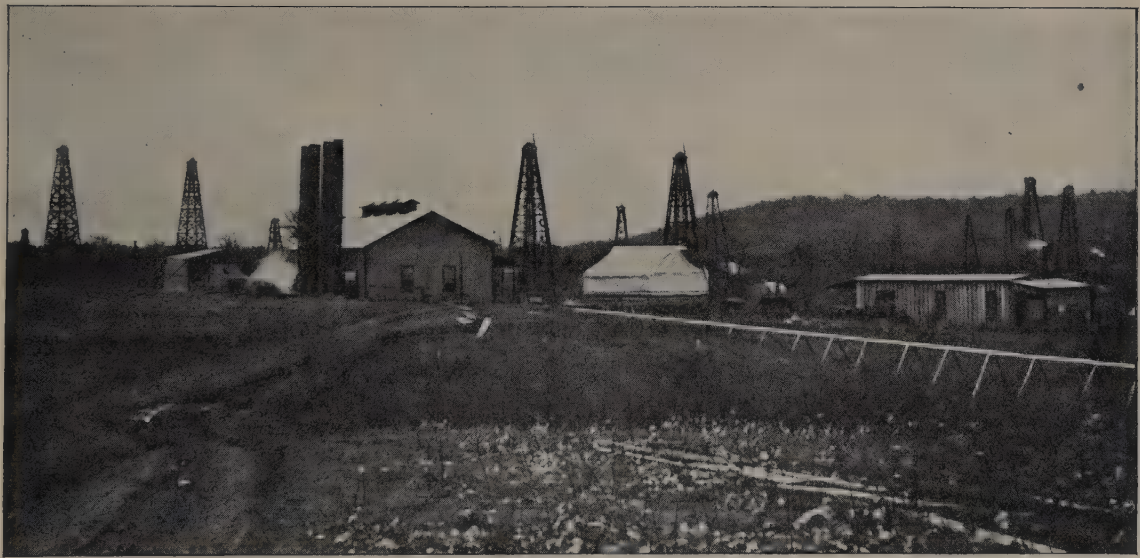
258 © Brown Brothers

259 A Lake of Oil. © Brown Brothers

260 Courtesy of the Tide Water Oil Company, New York

A PUMPING WELL

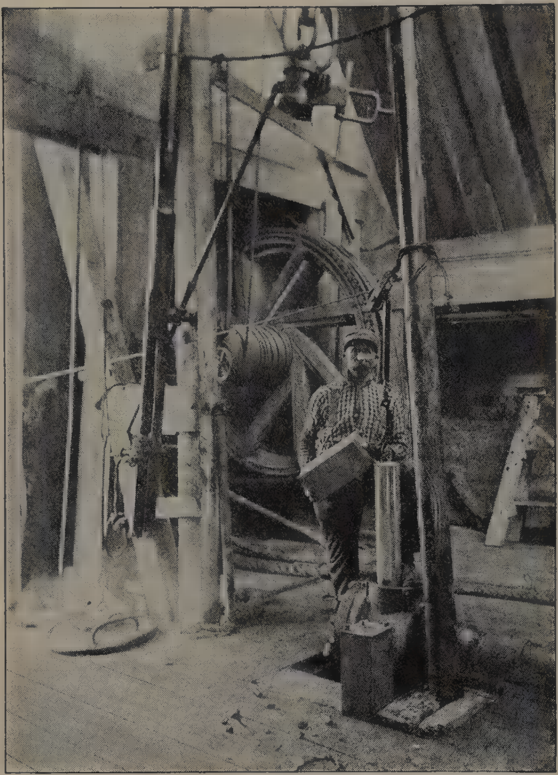
SOME wells contain enough gas under pressure to cause the oil to flow out of the well to the surface, thus giving rise to the name of "flowing" wells. In other wells the oil does not rise to the surface voluntarily and must therefore be pumped up from the bottom. Eventually gushing and flowing wells must also be pumped when the pressure that has caused the oil to rise to the surface has been released.



261 From a photograph by Sprague, Okmulgee, Oklahoma, courtesy of the *Oil Trade Journal*

PUMPING WELLS AND PUMP HOUSE

WHEN there are several wells within a radius of a few miles they may all be connected to one pump, the motion of the pumping engine being carried to the individual wells by rods just as the railroad towerman by pulling a lever causes distant semaphores to rise and fall. The small trestle at the right leading into the pump house carries the rod by which distant wells may be pumped from a central point. A corresponding rod runs from the opposite side of the pump house to the wells in the background.



262 From W. H. Jeffrey, *Deep-Well Drilling*, Toledo, Ohio, 1921

"SHOOTING" A WELL

Unlike water wells, oil wells are not permanent. Finally all yield ceases. In such circumstances the wells are sometimes "shot." For this purpose a torpedo containing nitroglycerine is lowered to the oil sands, and the charge exploded. The explosion or "shot" breaks up the sands, presents new surfaces and may for a time revive the productivity of the well. Sooner or later, however, the well becomes permanently dry despite repeated "shooting." This explains why it is necessary to discover ever new sources of supply of oil and why leadership in production passes from one field to another.

263 Courtesy of the Oil Well Supply Company

A GAS WELL BLOWING WILD

Mixed with petroleum there is usually more or less natural gas. In many cases the gas is discovered alone. Its quantity in the past has made it extremely cheap. As a result it has been scandalously wasted. Although it is the best fuel known, wells that have taken fire have burned for years without any attempt to put out the fire or save the valuable gas. Natural gas has been used for city lighting and was so cheap that it did not pay to employ men to extinguish the lamps by day, so the lights were kept going continuously. A common sight is that of a gas well blowing its valuable fuel into the air with no attempt to check the flow or save the fuel. To-day we are threatened with the entire disappearance of natural gas and are learning to preserve most carefully what we have.

264 From *Frank Leslie's Illustrated Newspaper*, Jan. 21, 1865

FILLING OIL BARRELS FROM TANKS

After the oil has been taken from the well it must be stored until it can be transported to the refinery. The earliest methods of storage and transportation were very crude. Since the oil wells were in an inaccessible location and because oil was a new thing, the earliest means of transportation were adapted from the carriage of known liquid commodities. The oil was stored in rough tanks in the field from which it was drawn off into barrels. These barrels were taken to the nearest town in ordinary horse-drawn wagons. Where water transportation was possible the barrels were loaded into flat-bottomed boats. The development of special tank cars and oil-carrying boats came with experience in the business.

265 From the motion picture *The World Struggle for Oil.* © E. F. Butler

HAULING OIL TO FLATBOATS IN THE 'SIXTIES

Immediately after the opening of the oil fields, oil was transported in cans upon the backs of men and horses. But soon teamsters monopolized the business. Loading the barrels of oil into wagons they hauled them to Oil Creek or the Allegheny River. The roads, where any existed, were in a deplorable state most of the time. This fact together with the great demand for teamsters caused the prices of oil haulage to rise very high. Often as much as four dollars a barrel for a distance shorter than a half dozen miles was asked and generally obtained; for the teamsters were a rough lot of men with whom might was right.

266 From F. M. Gillelin, *The Oil Regions of Pennsylvania*, Pittsburgh, 1864

"POND FRESHET" DAY ON OIL CREEK

The barrels of oil were transported to the river's edge and then loaded into barges. On account of the shallowness of Oil Creek it was necessary, in order to float the oil-carrying boats, to borrow a lumberman's trick; namely, create an artificial flood. The water was held back by dams and then at an agreed time the sluice gates were opened. On the crest of this freshet the oil boats dashed downstream toward the Allegheny River. In the excitement and crowding of boats caused by this scheme many a cargo was spilled overboard or the boats broken. "Flood days" were holidays along the creek and folks turned out to view the mad career of the barges. Permission to use the stream in this way had to be purchased from the owners of the dams — usually sawmill operators — and they charged "all the traffic would bear."

267 From *Frank Leslie's Illustrated Newspaper*, Jan. 21, 1865

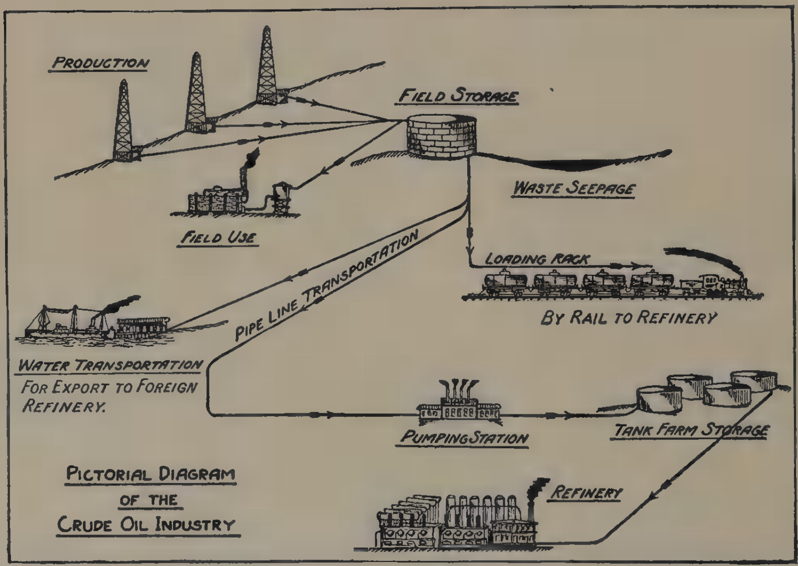
FILLING FLATBOATS FROM THE TANKS

The operators whose wells were along the banks of Oil Creek or the Allegheny River poured their oil directly into open, flat-bottomed, wooden boats. Much oil was lost in this way because the boats were often capsized by obstructions in the streams or by reason of the motion of their heavy liquid cargoes.

THE OIL CREEK RAILWAY, TITUSVILLE

Soon the railroads that entered Pittsburgh saw the possibilities of new business in the oil area and built tracks to points near the fields. At first the railroads piled oil barrels upon flat cars, and carried them just as a wagoner would. But soon the railroad men devised a special oil-carrying car. This was originally a huge wooden tub fastened to the flat car, but later the horizontal barrel type of car was devised. Eventually the same sort of car now used for transporting refined oil was employed to carry the crude to a refinery. The teamsters continued in the old manner to haul the oil in barrels to the railroad.

268 From *Frank Leslie's Illustrated Newspaper*, Jan. 21, 1865



269 From the *Report of the Petroleum Committee*, California State Council of Defense, 1917

FROM FIELD TO REFINERY

The modern organization of transportation partakes of the complexity of large-scale industry. Efficient methods and the large volume of product moved now make it possible to carry the oil from the well to the consumer at amazingly low cost.

The diagram illustrates merely the handling of the petroleum as it passes from the well to the refinery. From the refinery the products; gasoline, kerosene, and a multitude of others, pass through divers channels to the consumer.

AN OIL TANK ON FIRE

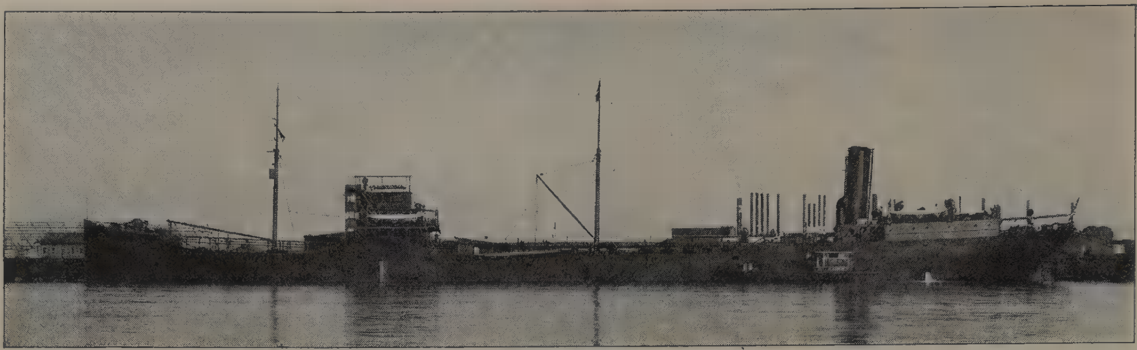
For bulk storage, both crude and refined oil are confined in huge tanks. The tanks may be in the field where oil is stored as it comes from the wells or they may be for "farm storage" at the refinery. The danger from fire is so great that storage tanks are generally located in isolated places and widely separated from one another. Around each tank there is generally a sort of earthen moat, and each tank is so piped that its contents can be quickly withdrawn in case of emergency. Despite every precaution the tanks frequently take fire and large amounts of oil are lost.

LOADING TANK CARS

In certain rare cases crude oil is drawn from field storage tanks into railroad tank cars for shipment to the refinery or to users of crude oil for fuel in its natural state. The tank car is the normal method of shipping refined oil by land from the refinery to local storage and distributing stations. The tank cars are shown at a loading rack of a Chicago refinery.

270 From a photograph by the United States Bureau of Mines

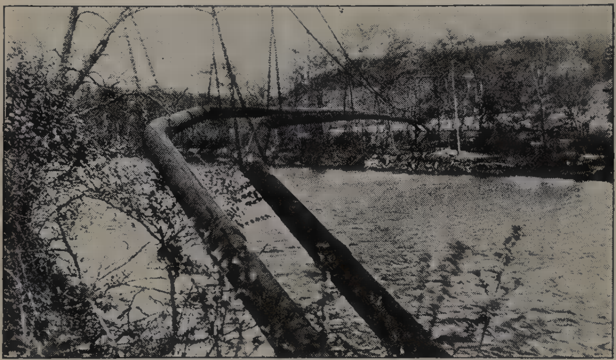
271 Courtesy of the Sinclair Consolidated Oil Corporation, New York



272 Courtesy of the Sinclair Consolidated Oil Corporation

AN OIL TANK STEAMER

From the field storage plant crude oil is sometimes run into great tank steamers to be carried to a foreign refinery. This is true of Mexican oil refined in the United States. The same kind of boat — even the same boat — is employed to transport refined oil to overseas markets. For oceanic transportation of oil an ordinary vessel was at first used. So many of them sailed from port never to be heard from again that eventually it was well-nigh impossible to get a sober man to ship on them. The constant loss of cargoes forced oil men to devise a boat especially equipped to carry oil. To-day these ships are so admirably arranged that with a hose they can be loaded or unloaded in a shorter time than it takes to provision them for a voyage. No other oceanic cargo is handled so expeditiously and hence so cheaply. The slow-going "tanker", rolling heavily in rough seas, has become a commonplace in an age when oil is sought in the farthest corners of the earth.

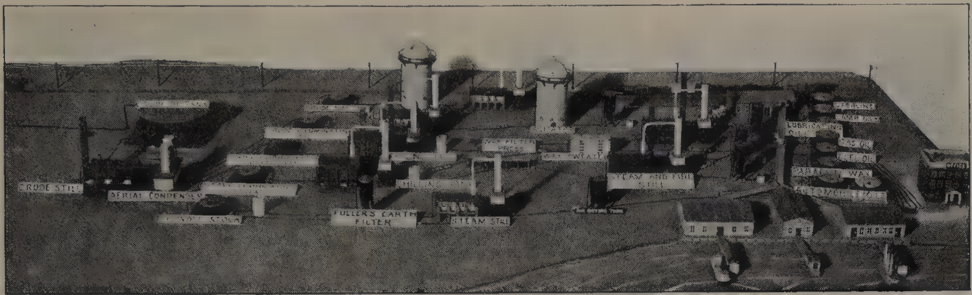


273 A Swinging Pipe Line over a Stream, courtesy of the Tide Water Oil Company

PIPE LINE TRANSPORTATION

Samuel Van Syckel of Titusville first demonstrated the practicability of sending oil from the field to the railroad in pipes. He built a small experimental line in the Titusville field, but despite the fact that it did not work well it was hotly contested by the "vested interests" — the teamsters. Indeed, the hardy horsemen tore up the pipes and threatened to shoot anyone who relaid them. They had considerable political power in the state and their opposition in the field and at Harrisburg delayed the introduction of pipe lines. But men cannot forever thwart a necessary economic device, and at last pipe lines were successfully laid. The first lines were short, from well to storage tank or from field to railroad. Proving their worth, they were extended and to-day crude oil travels from well to refinery in pipes. Oklahoma oil refined in Philadelphia makes the entire journey in pipes. Railroads no longer transport crude oil. There are upward of 50,000 miles of pipe line in the United States. The longest continuous line is that from Texas to the refineries at Bayonne, New Jersey.

274 Pipe Line Terminal at Bayonne, N. J., from a photograph by Brown Brothers



275 From a model in the United States National Museum

THE PETROLEUM REFINERY

THE immediate destination of most crude oil is the refinery. Here the oil is distilled and redistilled. First the light oils are separated, then the heavy oils, and finally the residue is made into wax, tar, coke, and numerous other products. No one knows the limit of possible products derivable from crude oil, but already some five hundred have been obtained. The chemist is busily at work on undeveloped possibilities.

276 An Old-Time Refinery, from F. M. Gillelin, *The Oil Regions of Pennsylvania*, Pittsburgh, 1864

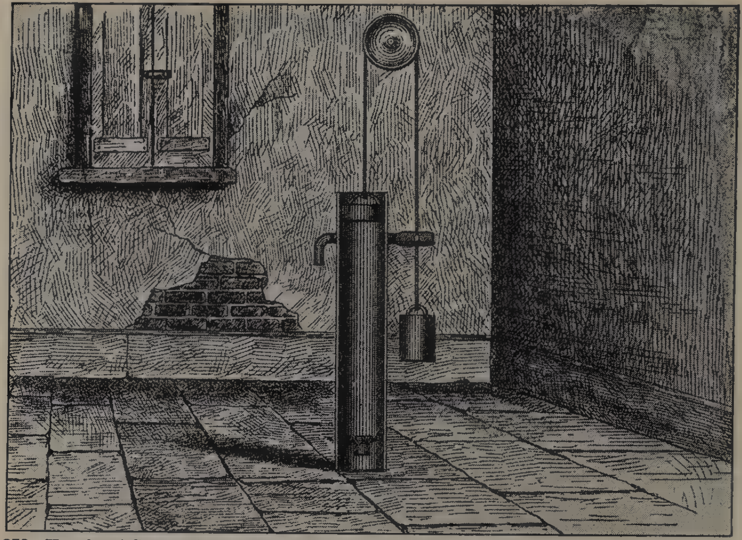
The old-time refinery was on a small scale and located near the oil fields. A modern refinery to be economical must be operated on a large scale so that every possible product may be secured from the crude petroleum. This is an important factor in determining the location of the refinery. As oil fields constantly vary in the amount of yield and as the center of production changes from year to year, the huge investment in a large refinery would be wasted if the refinery were located primarily with reference to the producing field. The location is generally chosen with relation to the market, access to the producing field being secured by pipe line. This arrangement permits more highly centralized control and consequent economy over scattered small-scale operations.

METHODS OF DISTRIBUTION

THERE are many variations in the method of sending oil from a refinery to the consumer. At the refinery the oil is generally run into tank cars for railroad transportation to a local district storage tank farm. If the refinery is on the coast some of its refined oil is piped to tank ships. These boats carry the oil either to a foreign market or to a domestic local district storage tank farm. Case oil is a refined product put up in small cans packed two in a wooden case. This oil is generally intended for foreign markets where transportation is by pack men or pack animals, but some case oil is sold to domestic consumers. It is then handled like any other boxed freight by railroads or ships. If the refinery lies inland, it may ship its oil in tank cars to a seaport where the oil is loaded into tank ships. Or a seaboard refinery may use ships to carry oil to a convenient point where it is transferred to tank cars. Both tank cars and ships are used to carry oil directly to large consumers. Most oil, however, goes by car or ship to a district storage farm. From the district storage the oil is drawn into tank wagons or tank motor trucks. The latter usually transport the oil to local dealers who in turn sell it to consumers. But large consumers may be served directly by tank wagons or trucks from the storage farm. This outlines only the distribution of refined oil. The five hundred other refinery products are distributed in scores of ways. Petroleum has made a great contribution to civilization. So common have the products derived from it become that it is difficult to imagine life without it.

277 Distributing "Case Oil," African Coast. © Brown Brothers

THE OIL-DRIVEN ENGINE



278 Huyghens' Gunpowder Engine, 1680 (reconstruction), from *The Growth of Industrial Art*, Washington, 1892

THE invention that has given significance to the world's production of oil is the gas engine. The steam engine (pp. 83–91) runs by the expansion of steam against a piston or by the principle of the turbine. A gas engine uses the expansion that comes from the explosion or burning of gas in a confined space acting against a piston. Since the explosion occurs inside the cylinder that contains the piston, gas engines are said to operate by "internal combustion" or explosion. A similar principle is involved in the firing of a cannon. The shell is propelled by the expansive power of the exploded powder behind the shell confined within a small space in the bore of the gun, the cannon itself being strong enough to resist explosion.

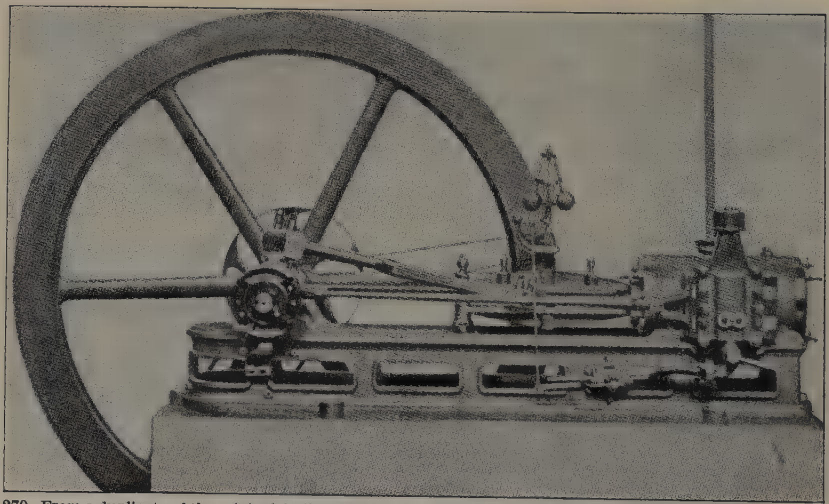
Although a successful internal explosion engine was unknown until the comparatively recent inventions of Lenoir, Otto, and Langlen, men have toyed with the idea for a long time. Among the first attempts was that of Hautefeuille, in 1678, who used the gas generated by the explosion of gunpowder to expel air in a chamber, whereupon the condensation of the gases produced a vacuum in the chamber. Huyghens, in 1680, devised a cylinder in which, after the vacuum was formed, atmospheric pressure pushed downward a piston at the top of the cylinder.

The first real gas engine appeared in 1791 when an Englishman named Barber invented an engine in which a stream of carbureted hydrogen gas was introduced by one induction port and atmospheric air at another. These two meeting and exploding produced a force to move a piston. In 1799 Lebon, a Frenchman, proposed the use of the electric spark to explode a mixture of air and gas in a cylinder, the consequent expansiòn furnishing a motive power.

GAS ENGINE OF LENOIR, 1860

FROM the time of Lebon various men of different nationalities experimented with gas engines. Among them were Brunel (1825), Brown (1826), Cooper (1835), Barnett (1838), Johnson (1841), Degrand (1858) and Huyon (1860). But the modern gas engine may be said to date from 1860 when Lenoir put a crude but practicable gas engine upon the market in France and the United States. This engine contained features, now familiar, of mixing air and gas in an enclosed cylinder, exploding them from a spark (obtained from a galvanic battery), and using the consequent expansion to drive a piston. Mechanical and automatic admission of air and gas in proper proportions, timing the spark, compression of the following charge by the return of the piston actuated by a flywheel, all these regular attributes of a gas engine were contained in Lenoir's inventions.

The first cost of a Lenoir engine was high and it had to be watched to prevent overheating, but its operation was cheaper than a steam engine for small horse powers, and it consequently became popular in the United States and France.

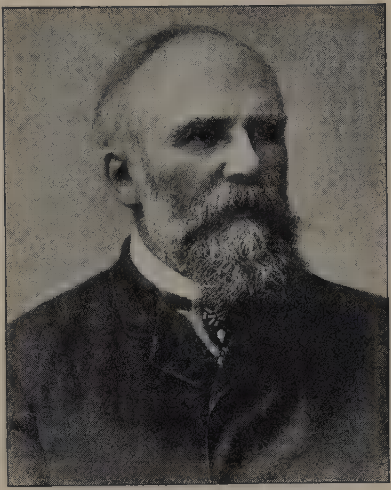


279 From a duplicate of the original, built by Lenoir for the Conservatoire National des Arts et Métiers, Paris

280 Nicholas August Otto, 1832–1901, courtesy of the Otto Engine Company, Philadelphia

THE OTTO ENGINE

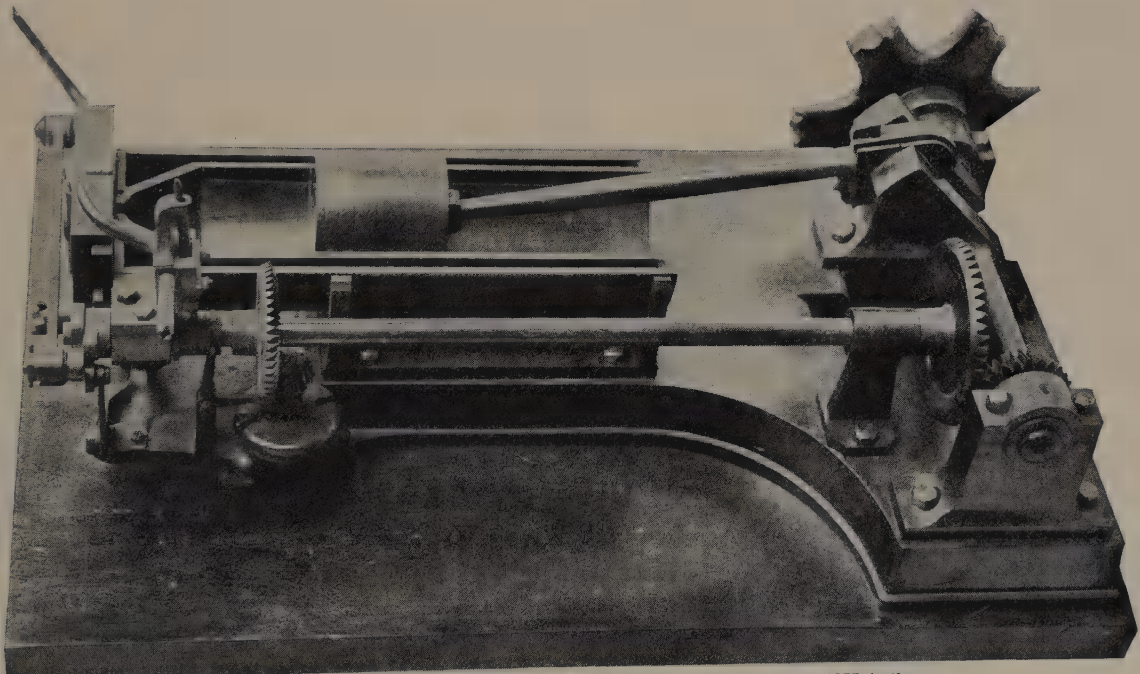
Nicholas August Otto, the inventor of the four-cycle gas engine, up to the time he was twenty-nine years old was engaged in commercial pursuits, but he had a keen interest in physics. Although his first experiment with gas engines was a failure it led eventually to success. The engine came to the notice of Eugen Langen, a member of one of the most prominent industrial families of Germany and possessed of a thorough technical training. Langen, too, was an expert designer. The friendship of these two men, beginning in 1864, lasted for their entire lives.



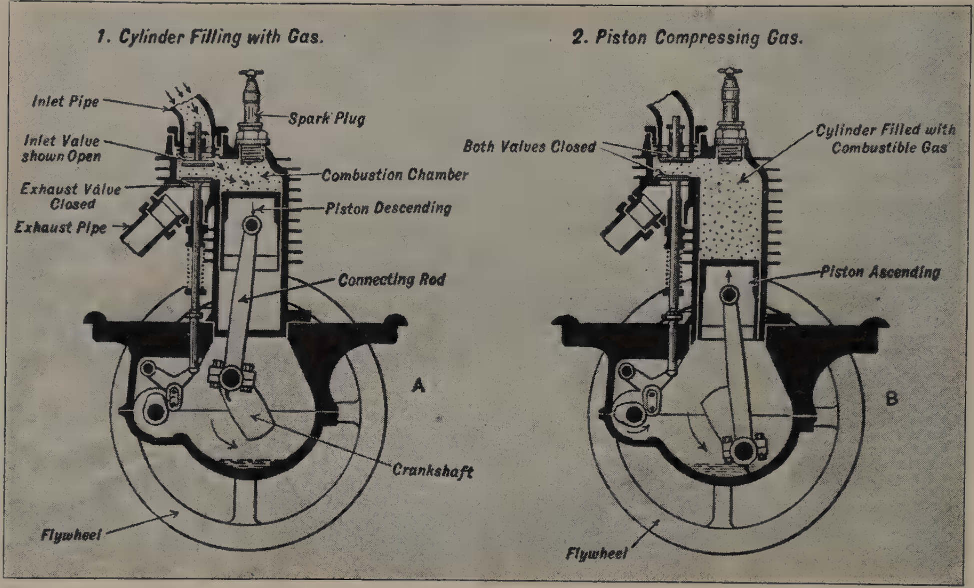
281 Eugen Langen, 1833–1895, courtesy of the Otto Engine Company

The combined talents of Otto and Langen produced an engine worthy of exhibit at the World's Fair at Paris in 1867. Otto's engine was despised for its crude appearance and its noisy operation but when gas consumption of the three engines exhibited at the Fair was measured, it was found that Otto's engine ran with less than a third the fuel of Lenoir's and less than half of Huyon's. This success led to orders and Otto manufactured some five thousand of these engines, ranging in power from one third to three horse power.

But Otto and Langen were unsatisfied. Their engine was limited to small horse powers, was noisy, and was uncertain as to its gas mixture. To improve these features Otto and Langen invented, in 1876, the four-cycle engine as it is now known. They worked out the proper proportion of the fuel charge — gas and air — and provided for proper ignition and combustion. This engine cut the cost of gas engine operation in half and paved the way for the marvelous development of gas engines in recent years from which have come the automobile and airplane.



282 Otto's Four-Cycle Engine, from the United States Patent model of Aug. 14, 1877, in the United States National Museum

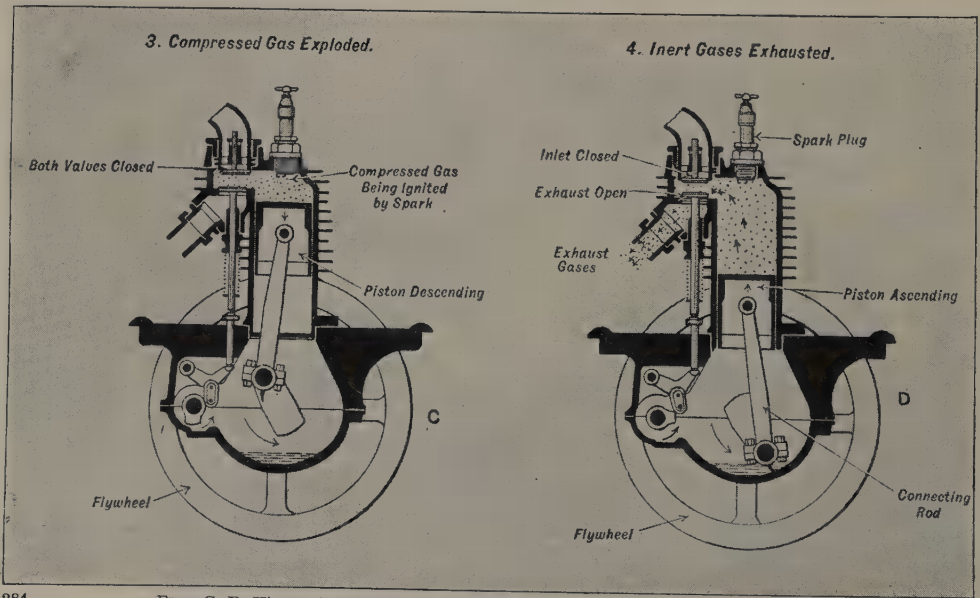


283 From G. D. Hiscox, *Gas, Gasoline and Oil Engines*, Norman W. Henly Company, 1915

THE STROKES OF A FOUR-CYCLE ENGINE

The operation of a gas engine may be easiest understood by reference to the diagram of the four-cycle engine, which gets its name from the fact that it requires four strokes of the piston to produce one power impulse stroke. As the piston moves away from the cylinder head the first time, mixed air and gas are drawn into the cylinder. This is the first stroke. The second stroke compresses this mixture as the piston returns to the cylinder head. An electric spark from the spark plug explodes the gas and air and drives the piston back upon the third or power stroke. The fourth (or second return stroke) forces the exhaust gases from the cylinder, when the cycle begins again. The energy derived from the power stroke is stored in a flywheel which, continuing to revolve, carries the piston through its three non-power-producing strokes. The mixtures are admitted and exhausted by properly adjusted valves.

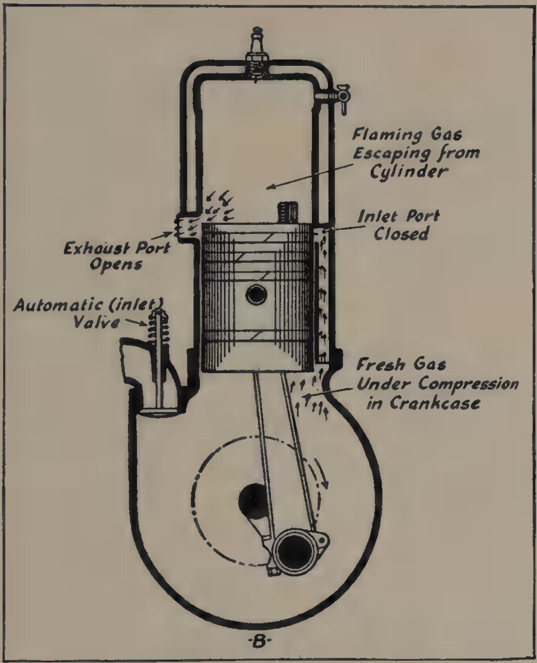
A single cylinder engine produces power, therefore, upon one out of every four strokes. To gain a more even flow of power, more cylinders may be added and attached to the crank shaft. For automobile engines four, six, eight, and even twelve cylinders have been joined together to form one power unit.



284 From G. D. Hiscox, *Gas, Gasoline and Oil Engines*, Norman W. Henly Company, 1915

THE STROKES OF A TWO-CYCLE ENGINE

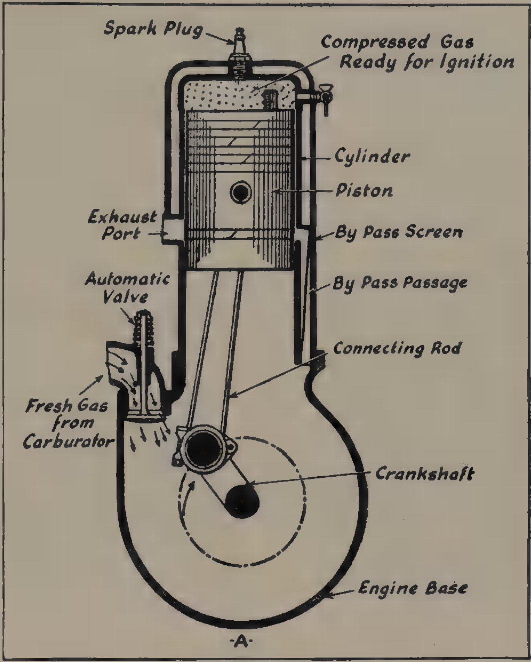
THE two-cycle engine produces power every other stroke of the piston. On the first stroke (A) the piston rises to the cylinder head, compressing the mixture of gas and air above it and drawing a fresh mixture from the carburetor into the engine base. At the same instant, the explosion of the compressed gas at the cylinder head drives the piston down.



286 From G. D. Hiscox, *Gas, Gasoline and Oil Engines*, Norman W. Henly Company, 1915

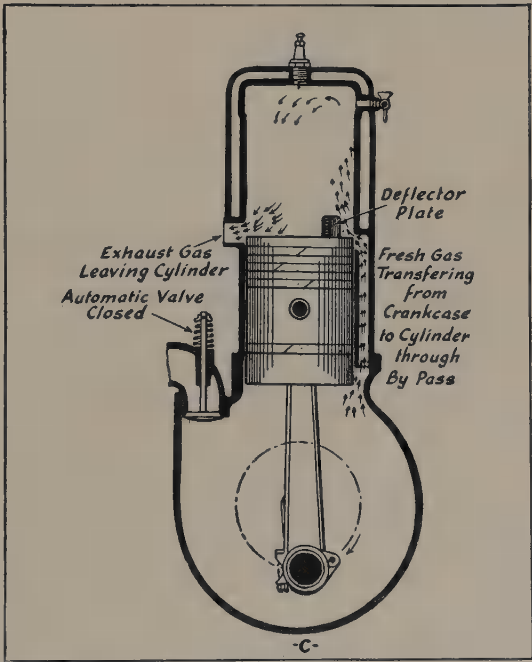
As the piston reaches the end of the downward stroke, the fresh gas drives out the remaining exhaust and, when the piston begins its return (C) to the cylinder head, both the intake and the exhaust port of the explosion chamber are closed. The energy in the whirling flywheel then drives the piston again toward the cylinder head in preparation for another explosion.

The two-cycle engine has a lighter flywheel than the four-cycle, and is notable for its absence of valves and valve mechanism. It is thus simpler and lighter in weight for its developed power, and theoretically should be more popular than the four-cycle engine. Practically its use has been confined to small power boats where its economy of space and weight and its easy reversibility commend it. But the overwhelming demand in the automobile business for a four-cycle engine whose principle and repair are more easily understood by the ordinary owner and garage mechanic has caused engineers who design and improve internal combustion engines to neglect the two-cycle type.

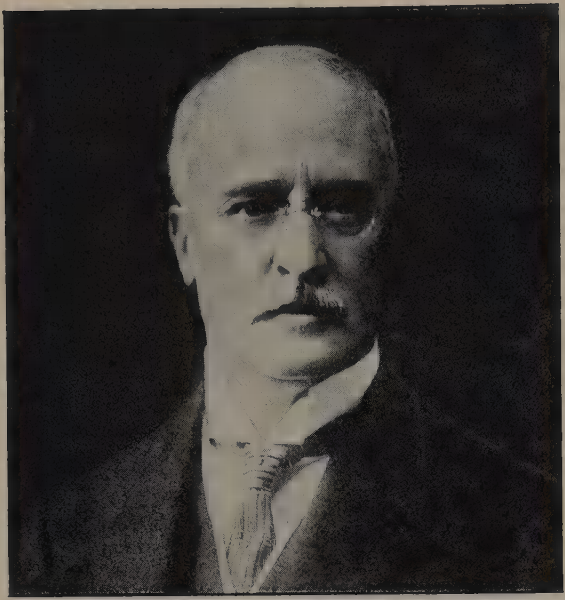


285 From G. D. Hiscox, *Gas, Gasoline and Oil Engines*, Norman W. Henly Company, 1915

As the piston approaches the end of the stroke (B) it passes the exhaust port out of which the flaming gas escapes. But this downward drive of the piston compresses somewhat the mixture in the engine base, and this moderate compression forces the fresh gas through a passage outside the cylinder and into the explosion chamber above.



287 From G. D. Hiscox, *Gas, Gasoline and Oil Engines*, Norman W. Henly Company, 1915



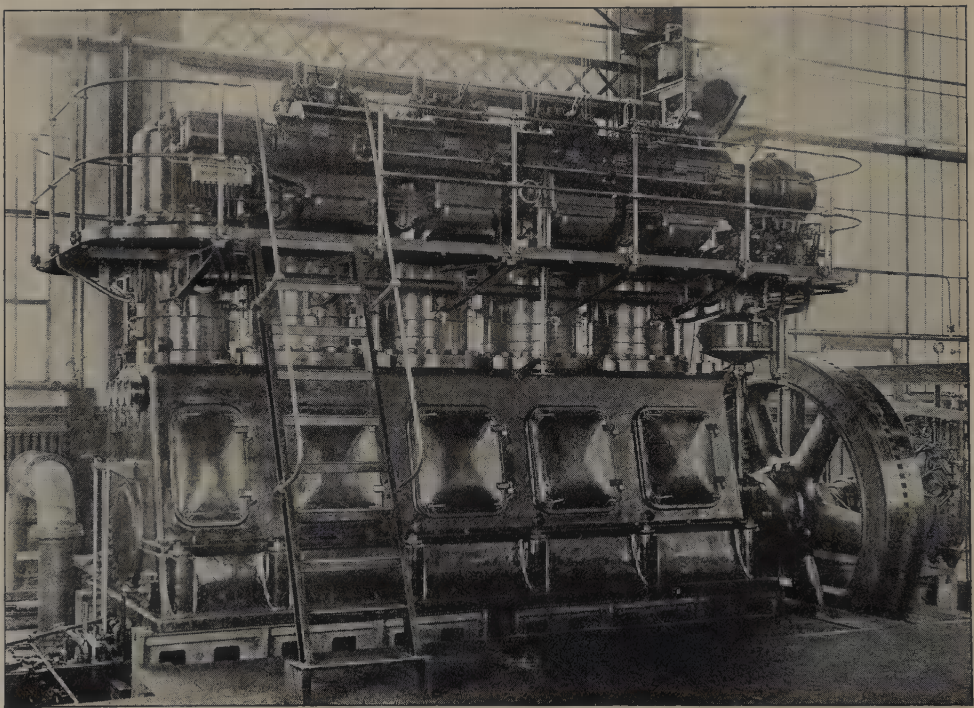
288 Courtesy of the Diesel Engine Company, St. Louis, Mo.

RUDOLF DIESEL, 1858–1913, INVENTOR OF THE DIESEL ENGINE

Rudolf Diesel, a true cosmopolitan, was of German parentage, born in Paris, and educated in England. His first work was in connection with the manufacture of ice in Paris. Later he turned his attention to the internal combustion engine. In 1897, at the age of thirty-nine, he succeeded in introducing a new gas engine whose utility was soon recognized and now assures its inventor a permanent place among the great innovators. During 1912–13 he lectured in the United States on the subject of internal combustion engines. Upon his return home he was called into consultation by the British Admiralty, but, while on his way, was drowned in the British Channel.

THE DIESEL ENGINE

The Diesel engine differs from all other explosive power producers by gaining a combustion temperature through the compression of pure air. The fuel is introduced gradually into the compressed air and burned with little or no increase in temperature during combustion. The motor although operating upon the four-cycle principle differs in considerable detail from the Otto type. The Diesel engine resembles exteriorly the ordinary vertical gas engine except that it is built to withstand higher pressures. In the operation of the engine the first stroke fills the cylinder with pure air which is compressed by the next stroke, creating a temperature more than enough to ignite the fuel. At the beginning of the stroke the fuel valve opens, and finely divided fuel is sprayed into the red-hot air. Combustion then takes place and power is produced. The used gases are finally exhausted. The Diesel engine runs as smoothly as steam, costs no more to install, is less expensive to operate and may be used with a great variety of low-grade fuels. On these accounts it is coming into widespread use.



289 Courtesy of the Diesel Engine Company

CHAPTER VII

THE ERA OF ELECTRICITY

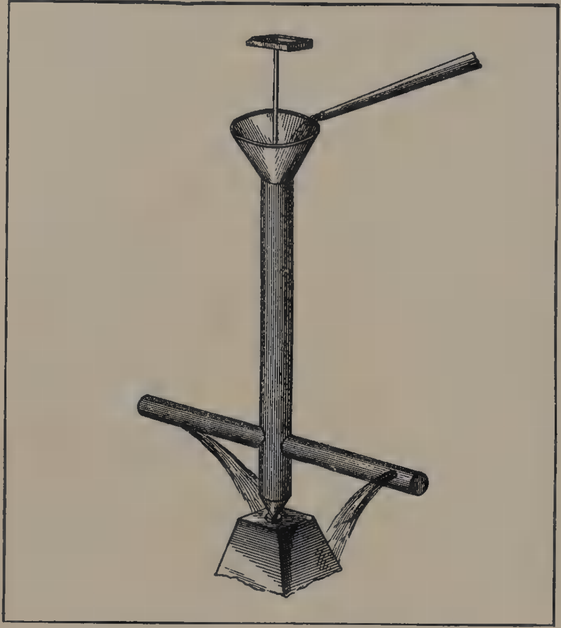
COAL and petroleum are but two of the sources of energy that have made possible the modern industrial era. Some six hundred years before the beginning of the Christian era the Greeks knew that when certain substances such as jet or amber were rubbed they had an attractive influence upon fragments of straw, feathers, or leaves. The Greeks did nothing with their observation of the peculiar behavior of amber but the memory of their knowledge still lingers in the word electricity from the Greek *elektron*, which signified amber. About 1600 A.D. an English physician, William Gilbert, undertook researches that opened the way to the "age of electricity." The story of the development of the knowledge of electricity is typical of that of all natural science. The work of experimentation and discovery has been done by many men in many nations. The resulting knowledge has become common knowledge. To the advance of electrical research colonial America in the person of Dr. Franklin made a significant and even spectacular contribution. But Franklin's work was exceptional in America. Not until near the end of the nineteenth century did the cultural development of the young United States reach a point where American laboratories could make contributions comparable to those of Europe. Yet Americans were as quick as any people in the world to apply the new energy to the needs of everyday life.

Before the Civil War an American had invented the telegraph; not long after the end of the struggle another American made practicable the telephone. The tremendous industrial expansion in the United States which followed the war between the North and South stimulated the application of electricity to all manner of needs. So came into being, to mention but a few things, the electric car and the railway locomotive, the arc light, the incandescent lamp, the wireless telegraph and, finally, the radio.

The water wheel, the first extensive source of power in America, yielded place to the steam engine, but of late water power, in a new guise, gives promise of coming once more into its own. The new wheel — the turbine — has rendered obsolete the older form of water wheels. The use of concrete for dams, power houses, and other works has vastly increased man's control over great or turbulent streams. Lastly, the conversion of the power derived from turbines into electricity has solved the problem of power transmission and has led to the development of power in places remote from the point of use.

All types of turbines differ essentially from overshot, undershot, and breast water wheels. The latter moved by reason of the weight or speed of water acting upon their circumference. The turbines, on the contrary, are all constructed either to use the force that originates from changing the direction of rapidly running water, or the energy released by water reactively when it issues from a surface. Water ran *over* and *under* the old-fashioned wheel, but it runs *through* the turbines.

From the low-roofed power-generating plants lying below the great dams thrown across the rivers, transmission lines supported by steel uprights radiate to distant points. As the mid-nineteenth-century railway with its graded roadbed and its steel rails spiked to wooden ties symbolized the age of steam, the gray transmission lines running over hills and across valleys, through woods and cultivated fields are symbols of the advent of a new era, that of electricity.



290 From *The Growth of Industrial Art*, Washington, 1892

BARKER'S MILL, *ca.* 1700

It is recorded that at the end of the seventeenth century, a Scotchman named Barker constructed a turbine, now historically famous as "Barker's mill." Almost nothing is known about either the man or his mechanism, although the latter is supposed to have looked as it is represented here. Barker's principle, upon which many turbines are now made, is that water issuing speedily from a small opening exerts a backward pressure or "kick." If the surface from which the water jumps is movable the kick given it by the water will set it in motion. "Barker's mill" resembles a rotary lawn sprinkler.

AN EARLY TUB WHEEL AT BOW, NEW HAMPSHIRE

Older perhaps than the Barker mill is the "tub wheel," an early form of turbine used in France centuries ago. In 1804 an American, Benjamin Tyler of Lebanon, New Hampshire, patented a "Wry-Fly" wheel which resembled the tub wheel. The remains of an old wheel in a sawmill at Bow, New Hampshire, seem to comply closely with the description of the "Wry-Fly" wheel. This wheel is the simplest and most primitive American turbine. The tub wheel got its motion from the kick given to it by the water jumping off the iron buckets inside the wheel.

291 From a photograph, courtesy of Arthur T. Safford, Lowell, Mass.

292 From a photograph, courtesy of Arthur T. Safford

SPIRAL WHEEL AT BOW

In the old mill at Bow, New Hampshire, where the tub wheel was found, the progress of turbine development in America can be traced by examining the wheels which replaced the original tub wheel. This was followed by a pair of spiral wheels, another early type of turbine that ran at comparatively high speed at a place where the distance between the height of the water above a dam and the water level below the dam was not great; that is, the water had a "head" of only a few feet. The twisting of the water as it went through the spiral gave the necessary kick to the wheel.

293 From a photograph, courtesy of Arthur T. Safford

A ROSE WHEEL AT BOW

THE spiral wheels were replaced by a pair of rose wheels (No. 293), which were of the impulse type, driven by a double jet. This type of wheel was not uncommon in America before the Civil War.

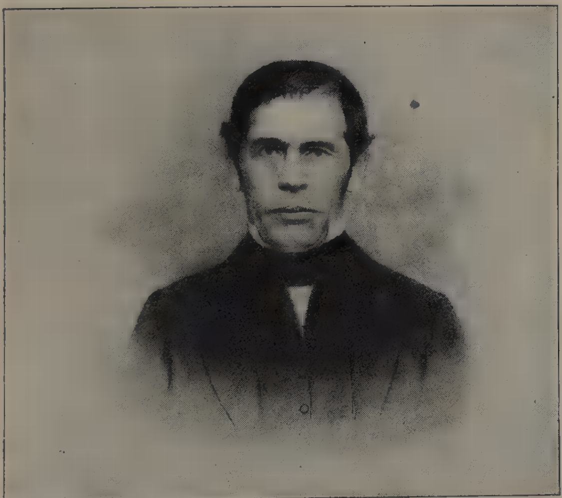
BOYDEN'S FIRST TURBINE, 1844

URIAH A. BOYDEN, an American engineer, designed a turbine that in its essentials, but with improvement in details, was the same as that of a French device developed by Benoît Fourneyron in 1827. This wheel was installed by Boyden in the mills of the Appleton Company, of Lowell, Mass., in 1844. The success met by the company in the use of the wheel led many other large corporations in New England to adopt it.

294 From the original in the possession of the Proprietors of the Locks and Canals, Lowell, Mass.

URIAH A. BOYDEN, 1804–79

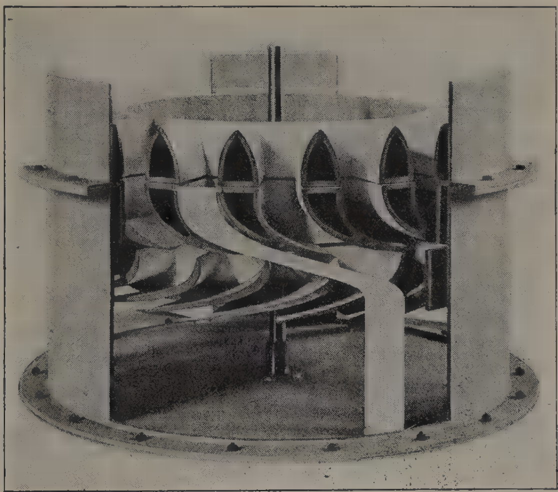
URIAH ATHERTON BOYDEN, born in 1804, was a younger brother of Seth Boyden of Newark, whose portrait appears on page 204 of this book. He worked with the staff of engineers who built the Boston and Providence Railroad; later he was employed on the construction of a dry dock at the Charlestown Navy Yard and was one of the engineering corps who built three mills at Lowell. These jobs established Boyden's reputation so that he was called in as consultant upon many engineering works. Accumulating a considerable fortune, Boyden spent his later life in the study of electricity, magnetism, light, meteorology, metallurgy, and chemistry. Boyden was also noted for his philanthropy.



295 From a crayon portrait at the Harvard Observatory copied from a daguerreotype taken about 1845

THE "INWARD-FLOW" TURBINE, 1841

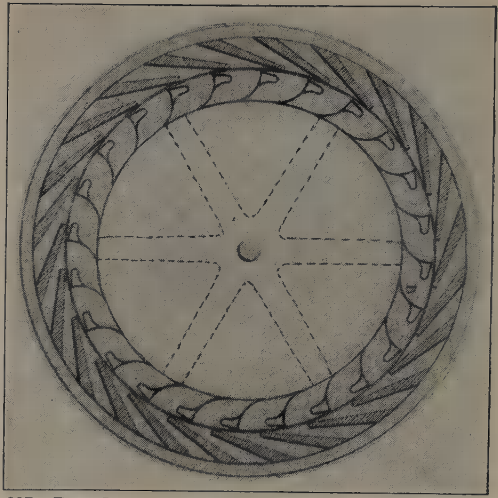
THE inward-flow turbine was patented in 1841 by a Frenchman named Jonval. This turbine received its water from above (or below) and turned it inward from the circumference toward the center. All similar wheels since have been called the Jonval type. The Fourneyron and Jonval became the two outstanding types of turbines, the former called the outward flow and the latter the inward flow.



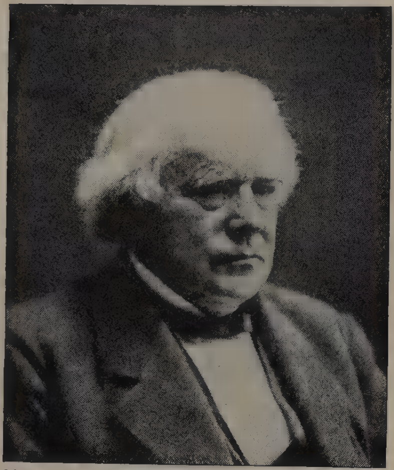
296 From a model in the Conservatoire National des Arts et Métiers, Paris

HOWD WHEEL, 1838, AN EARLY AMERICAN INWARD-FLOW TURBINE

SAMUEL B. HOWD of Geneva, New York, in 1838 secured the first American patent for a turbine that discharged inwardly. He did little with his patent, however, and later followed the example of the Lowell experimenters in developing a turbine with an outward flow.



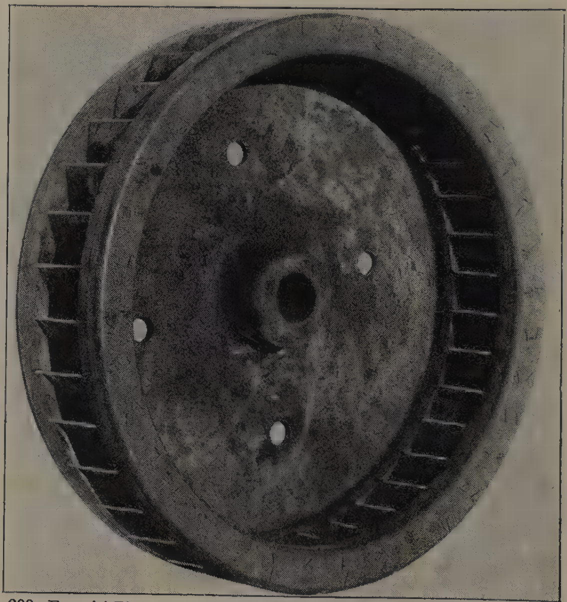
297 From J. B. Francis, *Lowell Hydraulic Experiments*, Boston, 1855



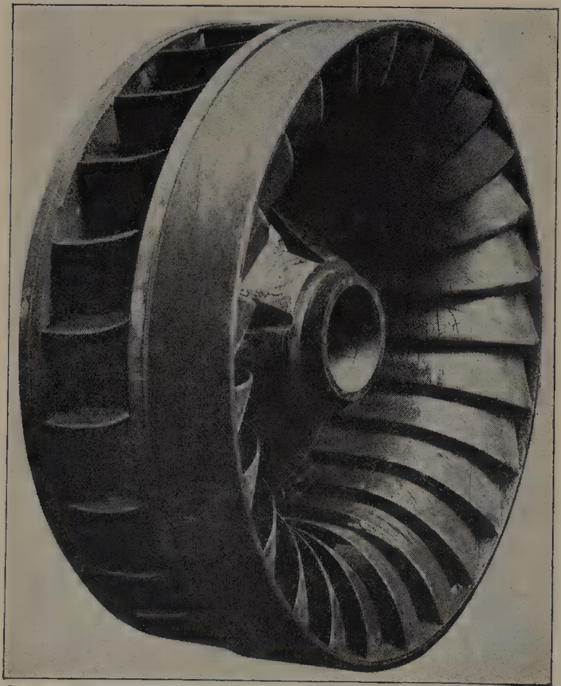
298 From a photograph taken at Lowell, in possession of the American Society of Civil Engineers, New York

JAMES B. FRANCIS, 1815–92

THE cotton manufacturers at Lowell, Massachusetts, continued to encourage the development of better methods of utilizing the water power of the Merrimac River begun in that city by Uriah Boyden. The agent of the manufacturers for many years was James Bicheno Francis, an Englishman, who came to Lowell in 1834 and remained the active head of the waterworks until 1884. Francis made an extensive study of hydraulics, in which he became a leading American authority. He experimented with various types of turbines, including those of Boyden and Howd, and made a number of improvements on the Boyden wheel. He became interested in the inward-flow turbine and in 1847 built his first experimental model, which was an improvement over the Howd wheel. The Francis wheel was built on scientific principles and developed a high efficiency.



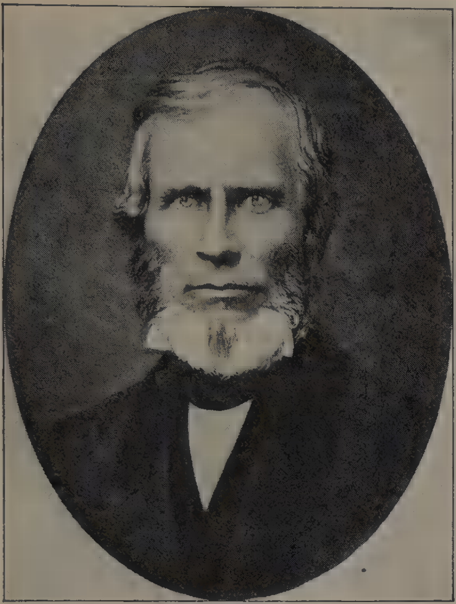
299 Francis' First Experimental Wheel, 1847, from the original in the possession of the Proprietors of the Locks and Canals, Lowell, Mass.



300 From a photograph, courtesy of Arthur T. Safford

"RUNNER" OF A SWAIN WHEEL

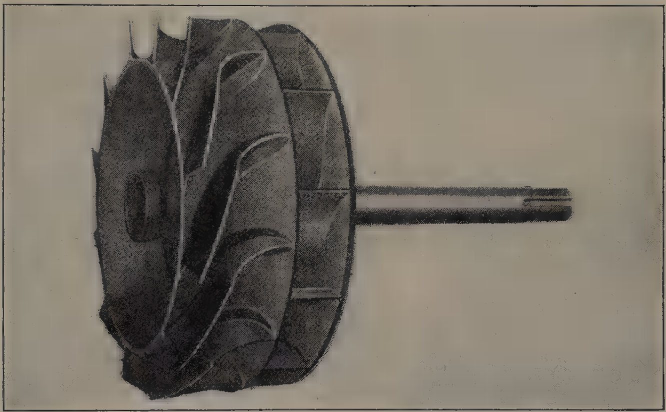
ANOTHER American inventor of turbines was Asa Methajer Swain, 1830–1908. His wheel was much like the Howd-Francis, except that it had deeper buckets and more of them. The discharge was inward and downward. His first model wheel produced in 1858 was only six inches in diameter but large Swain wheels were made later.



301 James Leffel, 1806–66, from a photograph in possession of Parkman Leffel, Springfield Ohio

THE LEFFEL TURBINE

In 1862, at Springfield, Ohio, James Leffel and Company began the manufacture of turbines. This firm introduced a novel wheel, the double turbine. It consisted of a regular inward-discharge Francis wheel, and below it another of the inward downward type. This turbine met with a wide sale and even to-day it still finds a market. This is all the more remarkable because the originator did not know — so it is said — just why the turbine worked as well as it did.

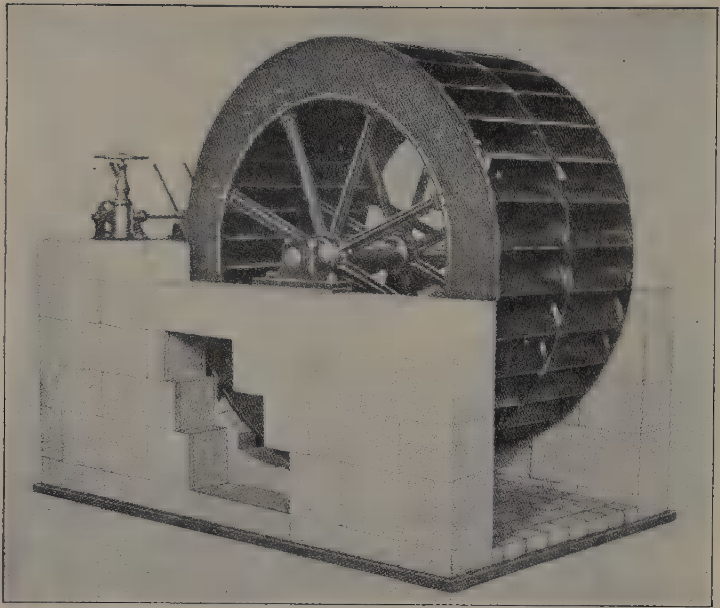


302 Leffel Runner, 1862, from a photograph, courtesy of Arthur T. Safford

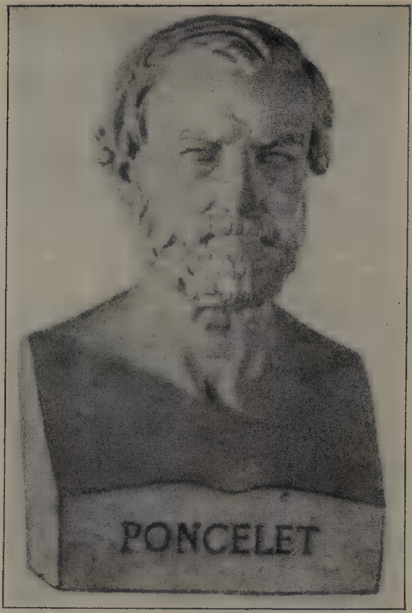
RUNNER OF A LARGE MODERN TURBINE

Although the early turbines were small, modern wheels attain great size, especially double turbines having both an inward flow and downward discharge. Such a wheel gets one set of impulses from the blades at the top and another as the water leaves the vanes on the bottom. Wheels of this character are used at the Muscle Shoals project.

303 From a photograph, courtesy of the William Cramp & Sons Ship and Engine Building Company, Philadelphia



304 The Poncelet Wheel, 1826, from a model in the Conservatoire National des Arts et Métiers, Paris

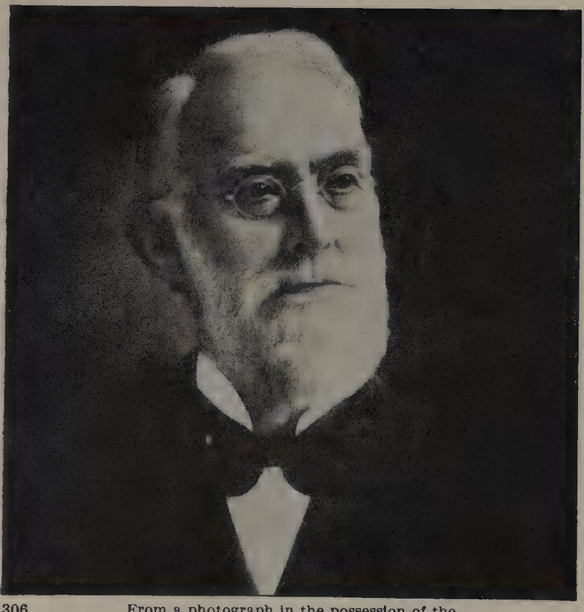


305 Jean Victor Poncelet, 1788–1867, from a bust in the Conservatoire National des Arts et Métiers, Paris

THE IMPULSE WHEEL

ANOTHER type of water wheel differing essentially from the old-fashioned impact wheel as well as from the turbine, is called the impulse wheel. It consists of a jet of water under high pressure directed against a wheel having vanes or cups on its circumference. Impulse wheels generally run at high speeds and are adapted to sites where the water has considerable drop or "head," as engineers call it.

In Europe the impulse wheel is credited to Poncelet, in America to Pelton. As an officer in Napoleon's army Jean Victor Poncelet was captured during the retreat from Moscow. While in captivity he made researches in mathematics, especially in geometry. His later work in this field gives him a claim to be considered the founder of modern geometry. As an outgrowth of his studies he became interested in practical mechanics and invented his famous water wheel in 1826.



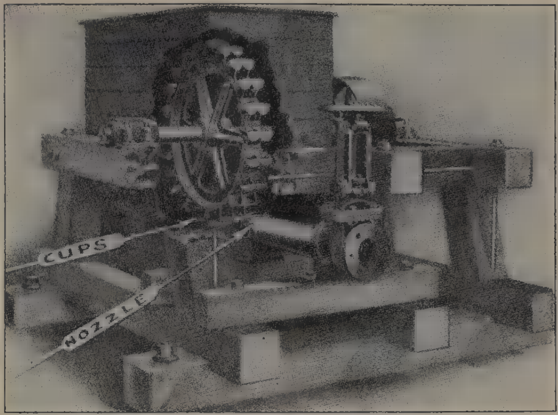
306 From a photograph in the possession of the Pelton Water Wheel Company, San Francisco

LESTER A. PELTON, 1829–1910, INVENTOR OF THE PELTON WHEEL

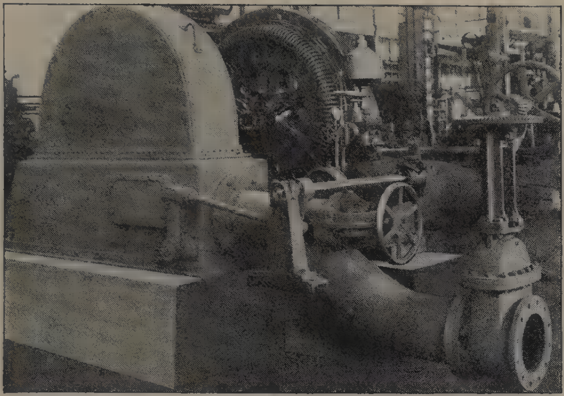
LESTER A. PELTON, whose name is given to the impulse wheel in America, was born in Vermilion, Ohio, in 1829. At twenty-one he drove an ox team from Ohio to the California gold fields, where for the next fourteen years he engaged in mining without much success. Mining called for power machinery, but steam-driven mechanisms were too costly, due to the long overland or sea journey of parts and also to the lack of fuel. Observing the power developed by the jets at the ends of sluicing hose in hydraulic mining, Pelton made experiments to determine the best kind of wheel to receive and utilize this energy. After many trials, he patented a wheel with specially shaped divided buckets on its circumference. For years Pelton struggled to get his wheel adopted, and at length in San Francisco received sufficient financial backing to make his invention a success.

A PELTON WHEEL OF THE 'EIGHTIES

A TYPICAL Pelton wheel of the 'eighties (No. 307) was a small affair and apparently simple in its details. Wheels of this character are still used for small installations. The water shooting out of the nozzle hits the cups and causes the turbine to revolve at high speed.



307 From a photograph, courtesy of the Pelton Water Wheel Company



308 From a photograph, courtesy of the Pelton Water Wheel Company

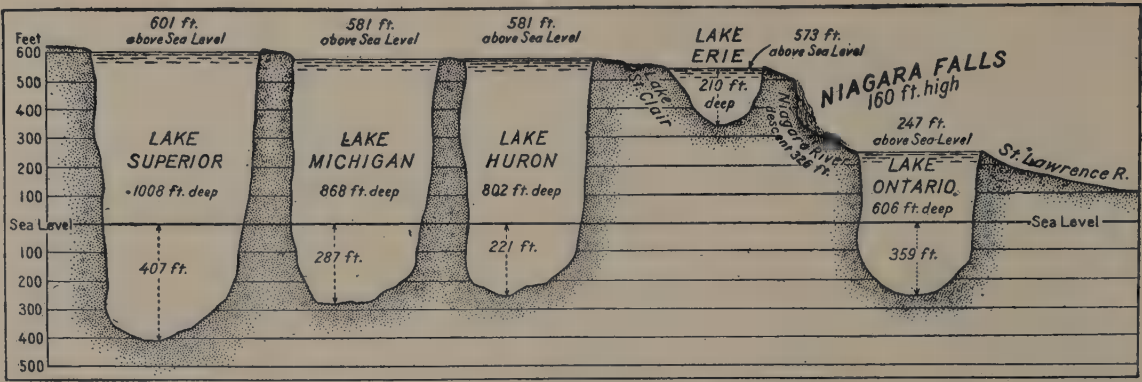
A MODERN PELTON WHEEL

CONSTANT experiment and improvement have developed large-size Pelton wheels (No. 308) used primarily in the production of electrical energy, but Pelton wheels as a class have never been as popular as turbines.

309 View of Niagara Falls from the Canadian side. © Rau Studios, Inc.

NIAGARA FALLS, A POWER SOURCE

THE invention and improvement of the turbine made it possible to develop water power on a large scale. Numerous power sites capable of yielding enormous power were for the first time in a position to be developed scientifically. Among the most noted and earliest of the attempts to utilize the turbine for water power was the harnessing of Niagara, begun in the year 1895 and successfully accomplished. The idea of utilizing the power of this great waterfall had occurred before, but with the wheels then available it was like trying to bind a giant with a thread.

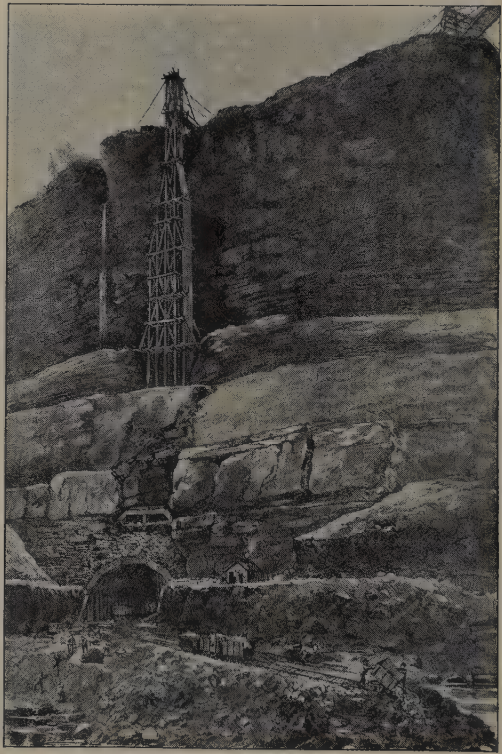


310 Redrawn expressly for *The Pageant of America*, by Gregor Noetzel from *Cassier's Magazine*, July, 1895

THE POWER BEHIND NIAGARA FALLS

THE diagram shows why Niagara Falls is a great power site. Back of the Falls are four enormous lakes — Erie, Huron, Michigan, and Superior. Acting as reservoirs for the Niagara River, they give it an even flow with little variation between high water levels and low, the most desirable condition for commercial water-power exploitation. The four upper lakes are from 326 to 354 feet higher in level than Lake Ontario. Of this difference 160 feet is accounted for at the Falls. The Niagara River is no shallow rivulet, but a mighty torrent twenty feet deep at the crest of the Horseshoe and flowing 275,000 cubic feet per second, with 6,000 cubic miles of water behind it to maintain its flow. As much potential power goes over the brink of Niagara daily as is contained in all the coal mined in a day throughout the world.

311 Digging the Canal, from *Harper's Weekly*, Dec. 26, 1891



312 Building the Tunnel, from *Harper's Weekly*, Dec. 26, 1891

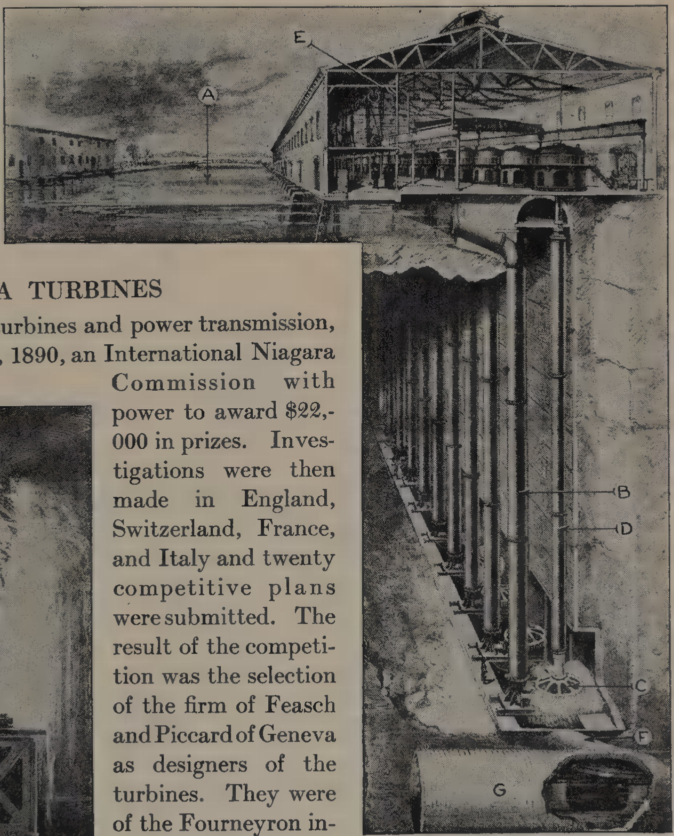
CONSTRUCTION WORK AT NIAGARA, 1891

THE first use of the enormous power available at Niagara was made in 1725, when a tiny bit of the stream was diverted to run a sawmill. Other small diversions followed. A more ambitious development, completed in 1861, consisted of a canal leading from above the Falls to a basin 214 feet above the current of the lower river. Upon the edge of the basin several mills were erected which in 1885 were using 10,000 horse power. In that year a suggestion was made by Thomas Evershed, a state engineer, for a far greater utilization of the power of Niagara by means of wheel pits a mile above the Falls with a tunnel discharging inconspicuously below, thus avoiding marring the beauty of the Falls. The project was taken up by a group of capitalists and construction was begun in October, 1890. It involved a huge excavation project.

313 From the *Scientific American*, October 20, 1894

VIEWS OF THE NIAGARA DEVELOPMENT OF THE 'NINETIES

A PIT was dug about a mile above the Falls and a quarter of a mile from the river. The pit was connected with the upper river by a canal (A). The artificial waterfall thus created at the pit was led into a series of pipes (B). At the bottom of each pipe was a water turbine (C). The power generated by the wheel turned a long metal column (D) standing in the pit beside the pipe. The upper end of this column ran into the center of an electric dynamo in the power house (E). The waste water was conducted away from the turbine by a short tunnel (F) which connected with a large tunnel (G), built at a slope sufficient to give the water a speed of twenty miles an hour. The tunnel discharged its water into the lower Niagara River. Such was the scheme for utilizing the energy of the Falls without defacing one of the finest bits of natural scenery in America.

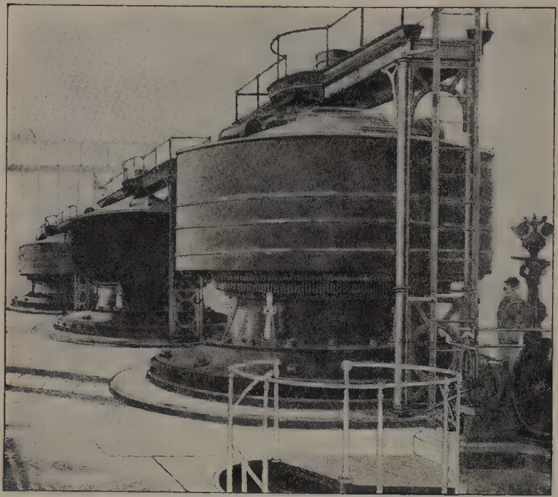


314 From the *Scientific American*, March 5, 1892

ONE OF THE NIAGARA TURBINES

To secure the latest information concerning turbines and power transmission, the company established in London in June, 1890, an International Niagara Commission with power to award $22,000 in prizes. Investigations were then made in England, Switzerland, France, and Italy and twenty competitive plans were submitted. The result of the competition was the selection of the firm of Feasch and Piccard of Geneva as designers of the turbines. They were of the Fourneyron inverted twin type.

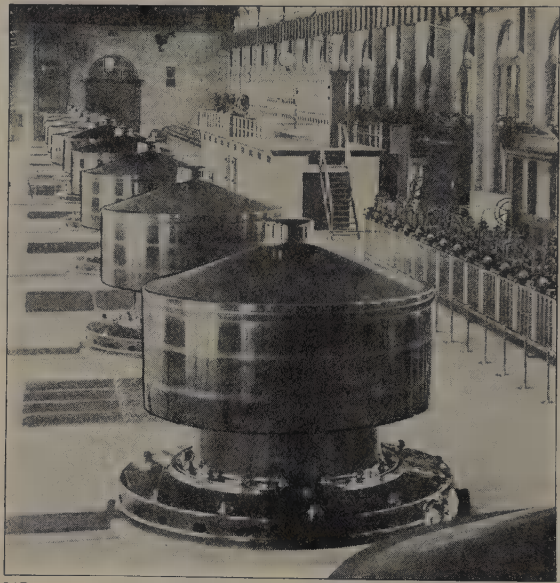
315 From the *Scientific American*, April 4, 1896



316 The 1890 Generators, from the *Scientific American*, Jan. 25, 1896

THE NIAGARA GENERATORS

Both the turbines and generators at Niagara attracted world-wide attention because of their unfamiliar size. In the original 1890 project ten generators were placed in line, one for each of the ten turbines of the project. These generators were each capable of producing 5,000 horse power. They were, however, but the first step in large-scale water-power mechanism. To-day the generators installed at Niagara are each capable of producing ten times the horse power which came from their predecessors of the 'nineties.



317 Modern Generators at Niagara, courtesy of the General Electric Company

THE FUTURE OF NIAGARA

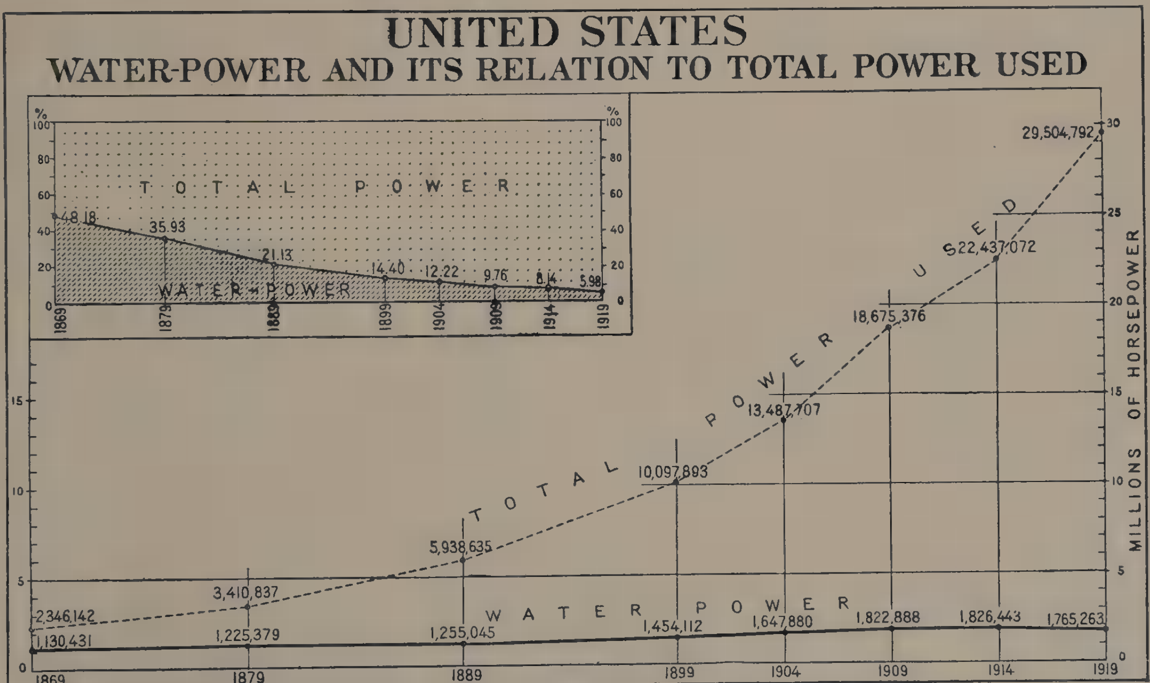
Since 1890 the utilization of the power of Niagara has vastly increased. In both the United States and Canada huge plants for generating electricity have been erected. In 1925 nearly 500,000 horse power were made available. Yet this is but a small part of the energy in the great falls which has been estimated at between 5,800,000 and 6,500,000 horse power. Compared with the theoretical possibilities the actual development is small. Yet men and women all over Canada and the United States have risen to prevent the marring of the beauty of one of the world's superb waterfalls. The fruit of their labors is a treaty ratified in 1910 between Great Britain and the United States limiting the ultimate utilization of power to twenty-five per cent of the total energy of the Falls. For generations men have stood beside that plunging cataract and have caught a glimpse of the mighty force pent up in nature. They have decreed that the generations to come shall not be robbed of a spiritual influence which is one of those imponderable yet potent factors in human life.

318 One of the Power Plants on the American Side. © Ewing Galloway

319 A California Pipe Line, courtesy of the Pacific Tank and Pipe Company, San Francisco

PIPING WATER TO A DISTANT TURBINE

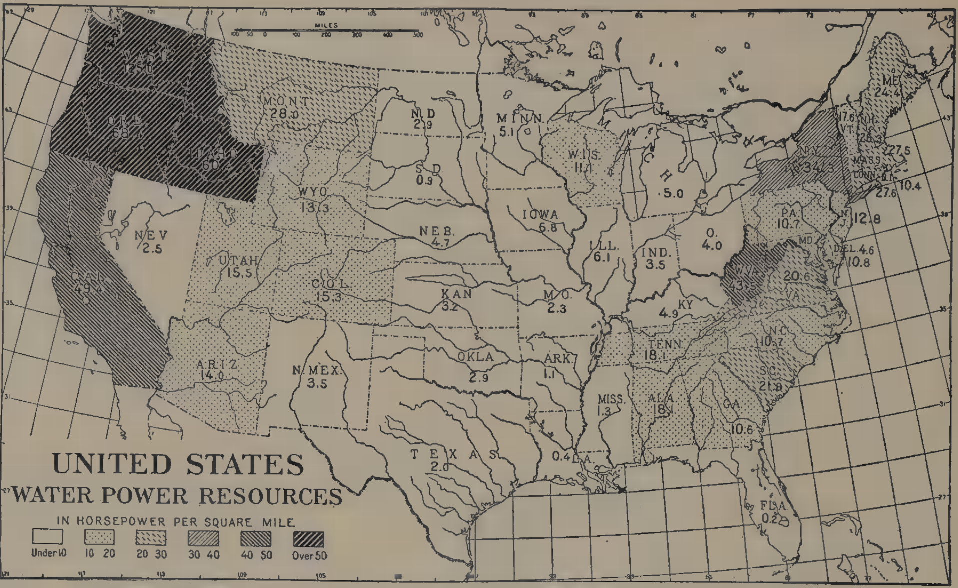
With the old-fashioned water wheels and some of the first turbines, water was carried from the stream above the dam to the power house by means of a surface canal known as the "intake" or "head-race." Such a canal was used in the earliest Niagara developments. One of the advantages of the modern turbine is that the ancient intake canal, expensive to build and to maintain, may now be discarded. Water for a turbine may be carried to the wheel in a pipe above or below ground, on the level, or up and down grade, in a straight line or curve. This flexibility greatly enhances the practicality of water-power development.



320 Drawn expressly for *The Pageant of America*, by Gregor Noetzel from data in the *United States Census of Manufactures*, 1920

THE RELATIVE IMPORTANCE OF WATER POWER

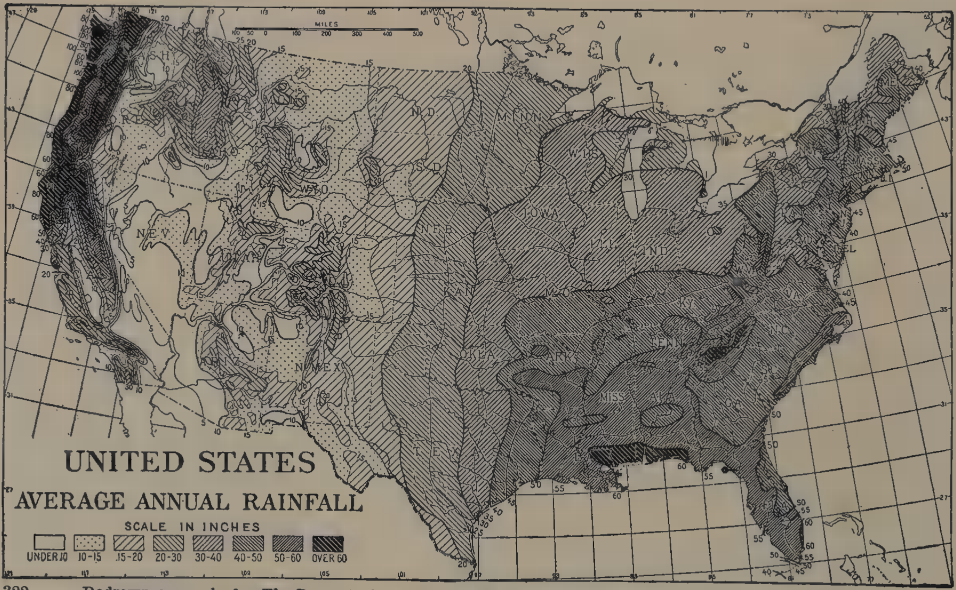
In considering the position of water power it is desirable to know, in terms of horse power, its actual increase, but still more the relation of the use of water power to all other sources of power. Statistics show that the use of water power has constantly increased, except during the World War period, but all other forms of power have likewise increased and at a much more rapid rate, so that the proportion of the total power that is supplied from water shows a constant decline. A revived interest in water power, however, is indicative of possible future expansion and on that account any present-day development of it deserves attention.



321 Redrawn expressly for *The Pageant of America*, by Gregor Noetzel from a map by W. B. Heroy for the United States Geological Survey

POTENTIAL WATER POWER AREAS

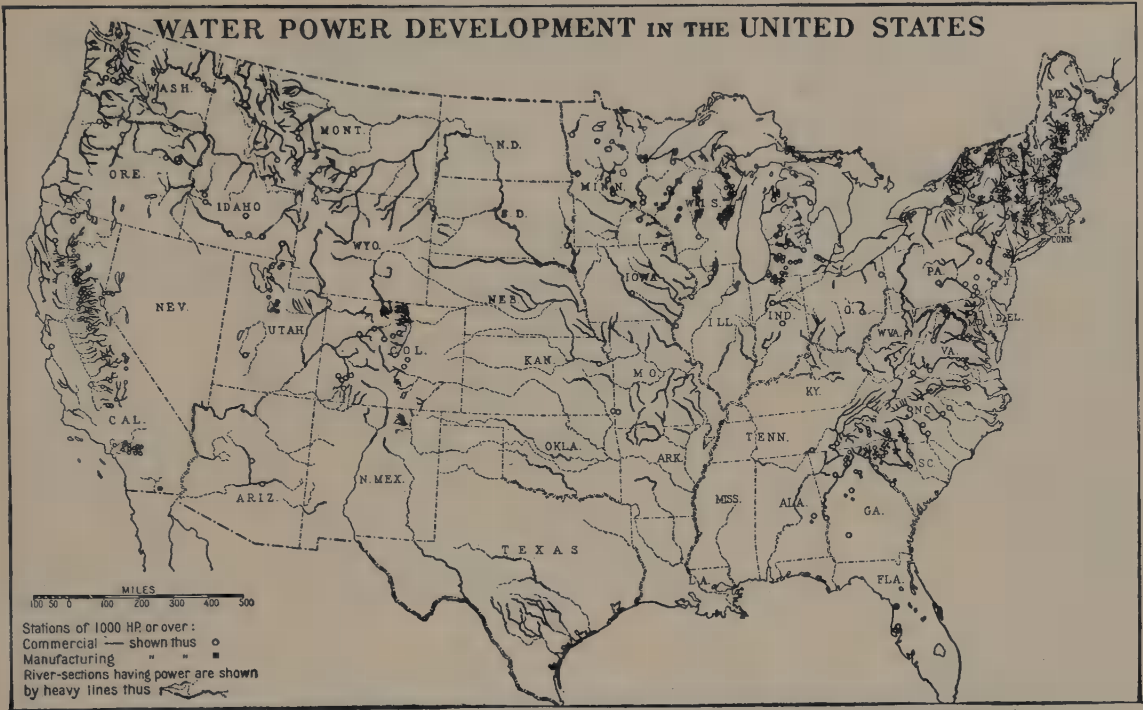
To calculate some of the future possibilities in connection with water power, it is of value to know where the potential water power sites are and also to have information concerning the amount of this potential power. As one would expect, it is the mountainous and hilly fringes of the United States that possess the greatest natural resources in probable water power.



322 Redrawn expressly for *The Pageant of America*, by Gregor Noetzel from a map by Henry Gannett for the United States Geological Survey

RELATION OF WATER POWER TO RAINFALL

Potential water power is naturally dependent upon rainfall. The areas of greatest rainfall in the United States are at the mouth of the Mississippi and in the Pacific northwest. All of the eastern states are, however, sufficiently blessed with rainfall. Another set of factors to be considered in dealing with water power is the slope and form of the land, the nature of the soil and its covering. The regions of heaviest rainfall are also the areas of most diverse topography. The Appalachians, the Rockies, and particularly the Cascades and Olympic Mountains are amply supplied with rainfall for water-power development.



323 Redrawn expressly for *The Pageant of America*, by Gregor Noetzel from a map in the *Report of the Commissioner of Corporations on Water-Power Development in the United States*, Washington, 1912

LOCATION OF WATER POWER SITES

The large number of power sites in the Mississippi valley and Great Plains draw from streams that rise in the rainy mountains. Most of the available valley sites have been taken up and future developments of water power must be looked for in regions that are not far from the mountains and which are bathed in copious rains or snows.

324 Power Plant, Turners Falls, Mass., courtesy of the General Electric Company

HYDROELECTRIC POWER IN NEW ENGLAND

To-day hydroelectric power plants are scattered over the entire country. In New England, where coal is costly, considerable interest and initiative have been shown in the development of the modern use of water power. High tension transmission lines lead from its mountains and hills to its industrial valley cities and towns and to places of dense settlement along the coast.

325 Cohoes, N. Y., Power Plant, courtesy of the General Electric Company

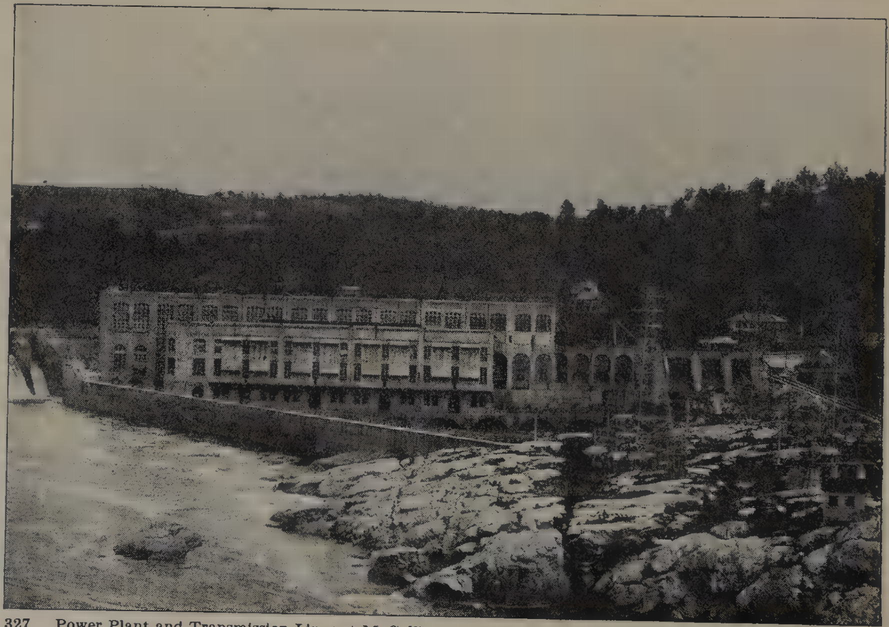
DEVELOPMENT IN THE STATE OF NEW YORK

THERE is a power station at the mouth of the Mohawk River where it enters the Hudson above Troy. Besides Niagara, the Adirondacks and Catskills as well as the uplands of southwestern New York present many potential and actual water power sites in the Empire State.

326 General View of the McCall's Ferry Development, from a photograph by C. F. Havercamp, Chester, Pa.

THE McCALL'S FERRY DEVELOPMENT

ONE of the largest power projects in the Middle Atlantic states is that at McCall's Ferry, Pennsylvania. Among other communities supplied from this source with hydroelectric power is the city of Baltimore. The characteristic transmission line is a set of wire cables strung from steel masts. Wherever modern water power is exploited the high tension transmission line is a familiar sight.



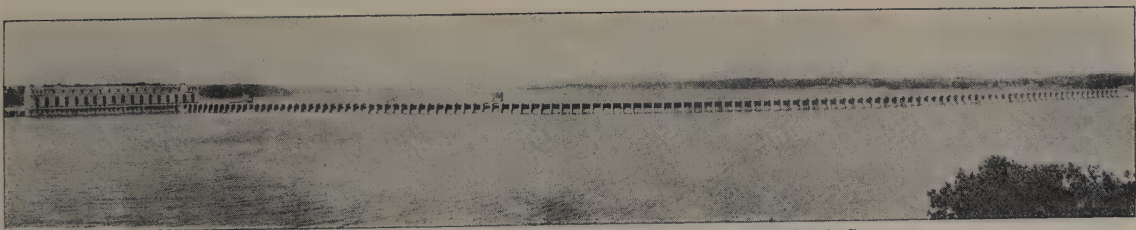
327 Power Plant and Transmission Lines at McCall's Ferry, Pa., from a photograph by C. F. Havercamp

328 Wilson Dam, Muscle Shoals, Alabama. © Ewing Galloway

WATER POWER IN THE SOUTH

One of the many reasons why the South seriously threatens the supremacy of New England in cotton manufacture is its large use of electrical power. Although coal-fired steam engines connected with generators produce some of the power, most of it is derived from waterfalls in the Piedmont.

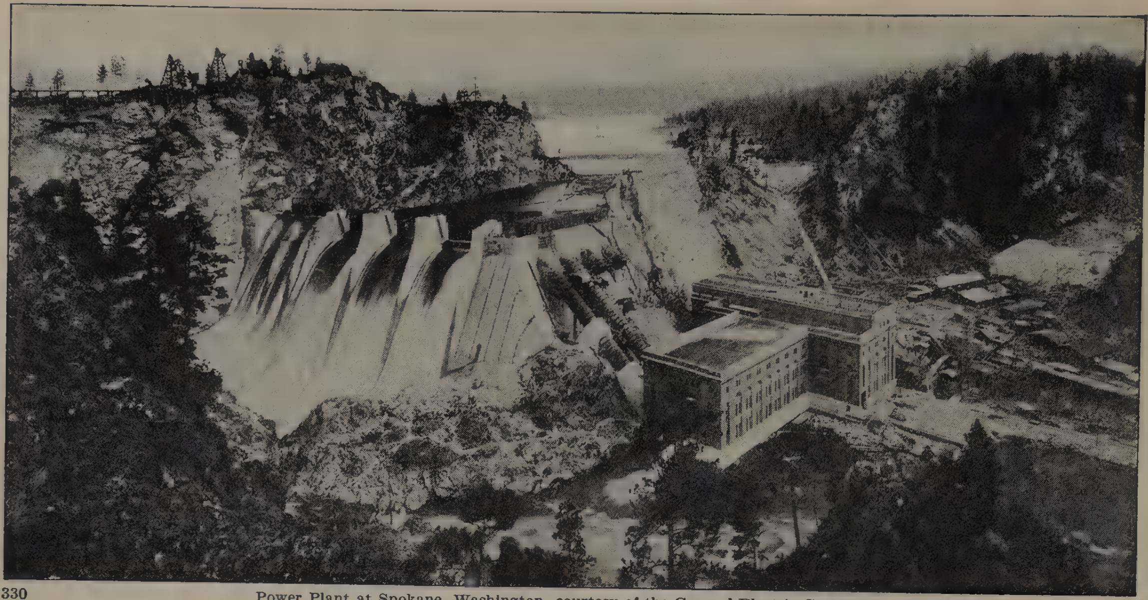
One of the most interesting and most discussed of southern water-power projects is Muscle Shoals, a work not yet completed when this was written. This undertaking is somewhat akin in present times to the harnessing of Niagara Falls in a former generation; in many respects it is comparable to the building of the Panama Canal.



329 Dam Across the Mississippi at Keokuk, Iowa, courtesy of the General Electric Company

HARNESSING THE "FATHER OF WATERS"

The Mississippi long defied the control of man except near its headwaters, as at the Falls of St. Anthony; but concrete has subdued this mighty river and electricity has made it useful in a new way. The power house at the extreme left has behind it the locks and dry docks necessary for navigation. Transmission lines carry Keokuk power far into Illinois as well as into Iowa.



330 Power Plant at Spokane, Washington, courtesy of the General Electric Company

POWER ON THE PACIFIC COAST

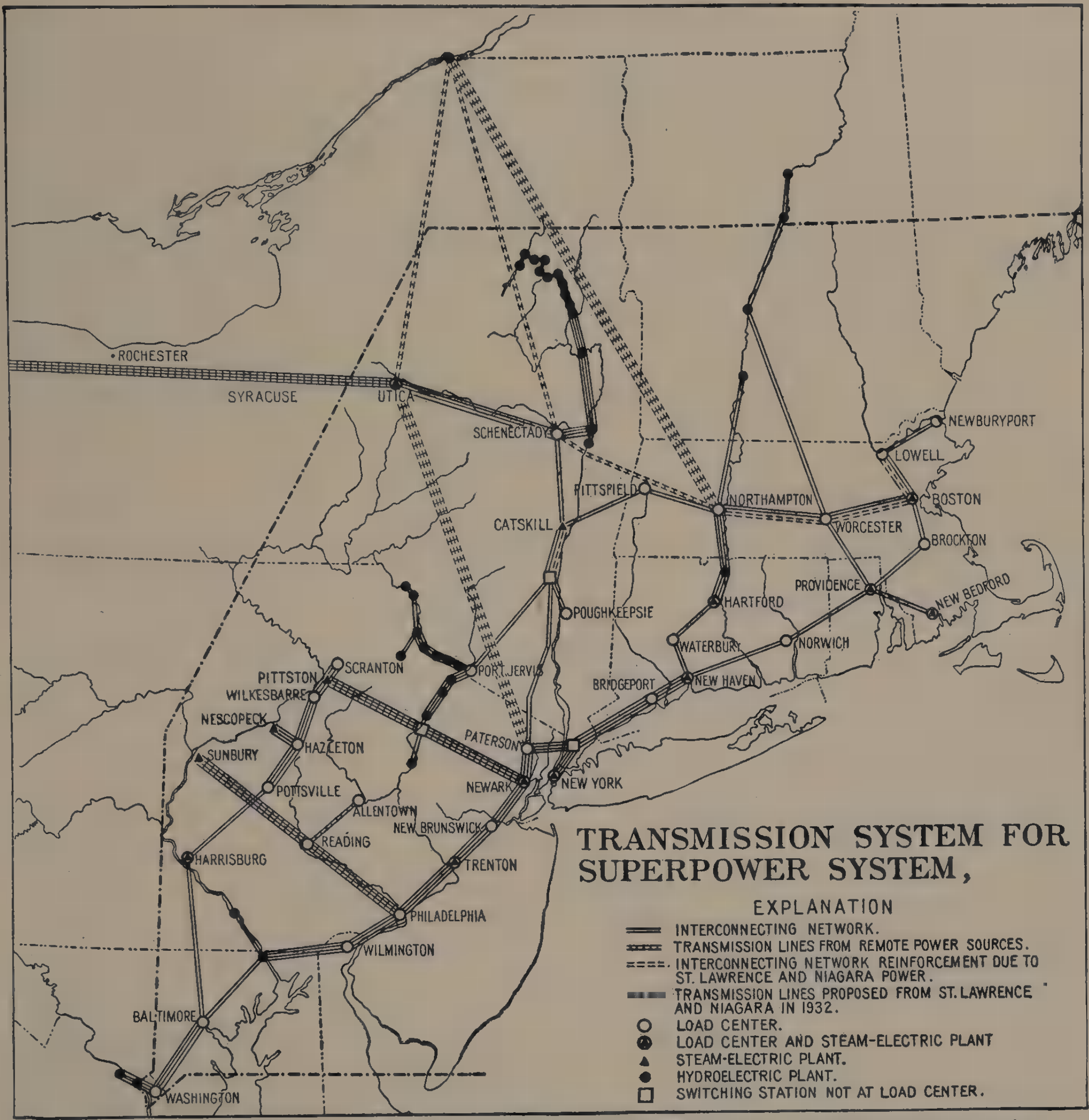
Washington and Oregon, with the precipitous streams of the Cascades and the Olympics, as well as those among the Rockies, hold the greatest future promise for water-power development in America. More than half of the potential water power of the United States is in this region.

LONG DISTANCE DISTRIBUTION OF POWER

A great advantage of modern turbines is that their power may be distributed in the form of electricity. This means that formerly remote, inaccessible power sites which were economically useless are now made available for man's benefit. The old mill had to locate at the source of power because of the limitation of water wheels and rope, wire or belt transmission. But the factory may now be placed at will and electric power carried to it. At first the range of electrical transmission was small: the first power-project promoters at Niagara, for example, debated whether they could send their power as far as Buffalo. Transmission for two hundred miles is now common and five hundred miles possible. This is with wires. If we ever have wireless transmission of power, no man can say what limit is to be placed upon the distance between the point of power production and power consumption.

A transmission line resembles a railway right of way. Straight across country, uphill and down dale, the procession of steel masts may be traced. Indeed, the power lines can climb grades and cross ranges that no railroad could surmount. In wild and wooded country a path is cut for the line and kept cleared of all growth. It is often the only opening in miles of forest land. Like the pipe line for carrying petroleum the transmission line is one of the triumphs of modern engineering skill.

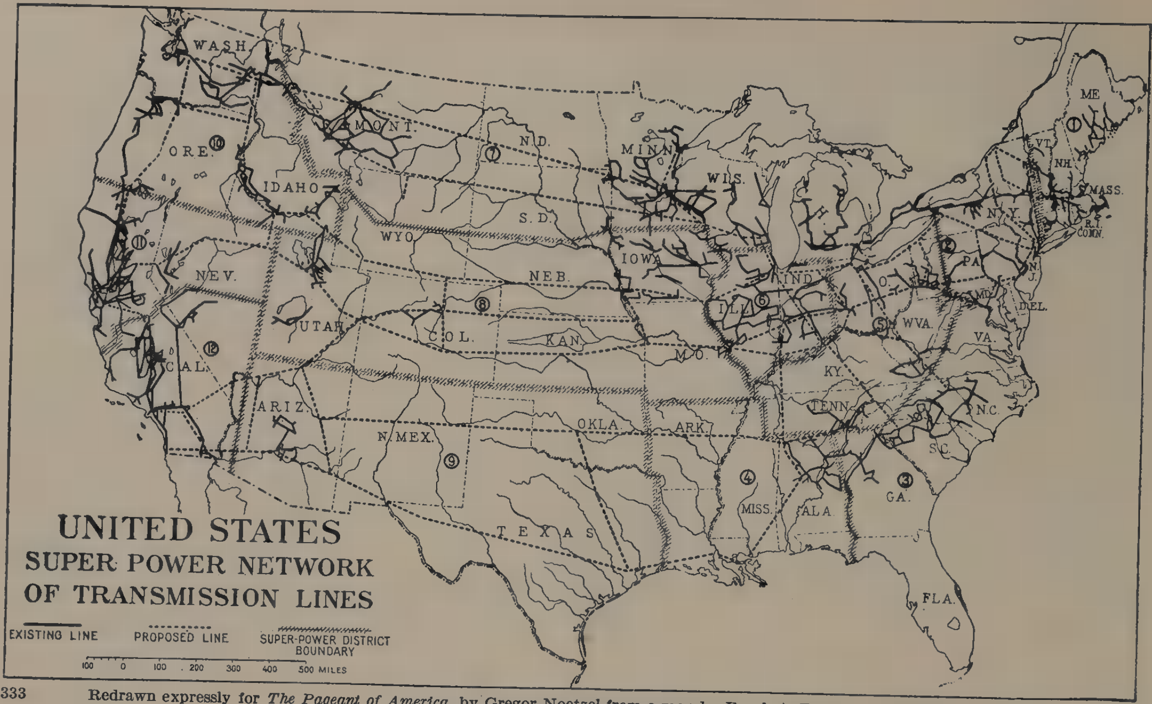
331 High Tension Transmission Lines from Holtwood to Baltimore, courtesy of the Consolidated Electric Light and Power Company, Baltimore



332 A Proposed Superpower System for the East. Redrawn expressly for *The Pageant of America*, by Gregor Noetzel from a map in *Professional Paper* 123, United States Geological Survey

GIANT POWER

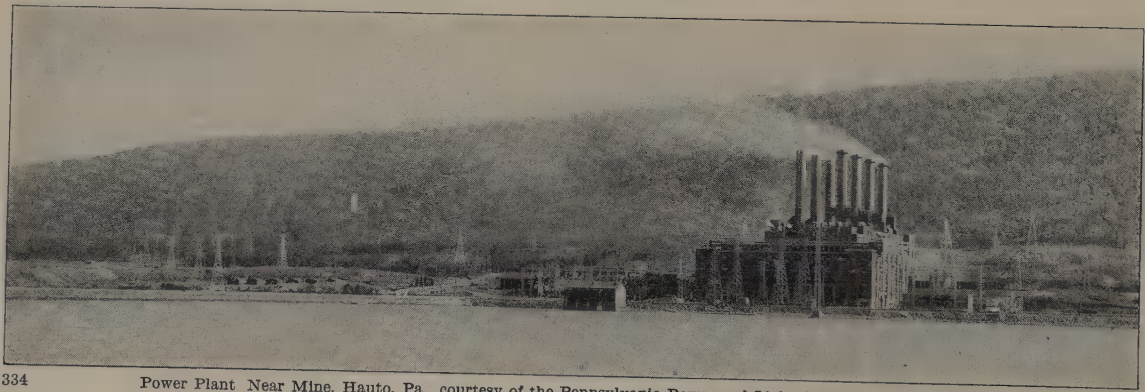
"We are on the threshold of a technical revolution. Through high voltage transmission lines, mechanical engineers are harnessing the rivers and the coal seams to electrical generators having the capacity of hundreds of thousands of horses. They are gathering the stored energy of the sun into reservoirs of power that compare with the isolated steam engine as a mobilized nation compares with the minute man. The forces for good and evil latent in Giant Power surpass those ushered in when Watt's engine harnessed coal to the looms of England. . . . The immediate objective of Giant Power is the conversion of all our primary energy resources into regional systems which will then be integrated into a nation-wide federation of systems. There is abundant evidence that our commercially available energy resources . . . are in process of incalculable increase. . . . For the mechanical engineers are far-visioned. They are dreamers of dreams. Most of the great inventions upon which the possibility of Giant Power rests were only recently little points of light in the groping imaginations of men whom even their professional colleagues regarded as impractical visionaries, as they once regarded Langley, inventor of the aeroplane. But mechanical engineers have developed a technique for the conversion of their dreams into realities." — Robert W. Bruère in *The Survey*, New York, March, 1924.



333 Redrawn expressly for *The Pageant of America*, by Gregor Noetzel from a map by Frank A. Baum in the *Atlas of the U.S.A. Electric Power Industry*, San Francisco, 1923

A VISION OF COUNTRY-WIDE SUPERPOWER

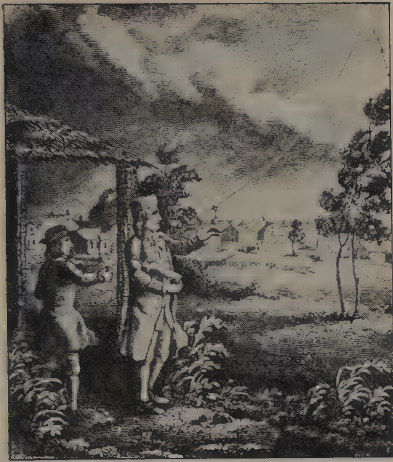
"Mechanical energy is the life blood of our modern civilization. Its volume, distribution and use, almost more than climate itself, condition the human environment. . . . In the United States the new technical revolution is still dominated by the same acquisitive drive which dominated the eighteenth century steam revolution. . . . Knowing in advance what is in Pandora's box, shall we let the lid be lifted — *laissez-faire*, let her rip — or shall we by taking counsel together, seek to win the nascent blessings of the new technical revolution without turning loose its potential plagues?" — Robert W. Bruère.



334 Power Plant Near Mine, Hauto, Pa., courtesy of the Pennsylvania Power and Light Company, Allentown, Pa.

GENERATING POWER AT THE MOUTH OF THE COAL MINE

Included in the "superpower" system are a number of steam electric plants. Some of these are along the coast and use water-borne coal, but the most interesting are those located at the coal mines. Hydroelectricity carried by wires from a remote source to users has demonstrated the feasibility of electric power transmission. This has suggested that the carriage of coal on congested railroads to individual power producers is economic waste. Great electric power plants at mine mouths are advocated whose power could be carried anywhere within two hundred miles and perhaps within five hundred miles. There is no place in the United States more than two hundred miles from a possible mine power house or a possible hydroelectric station. With a great superpower system, no man can predict what it would mean in economy, comfort and convenience.



335 From a woodcut by Alexander Anderson, about 1820

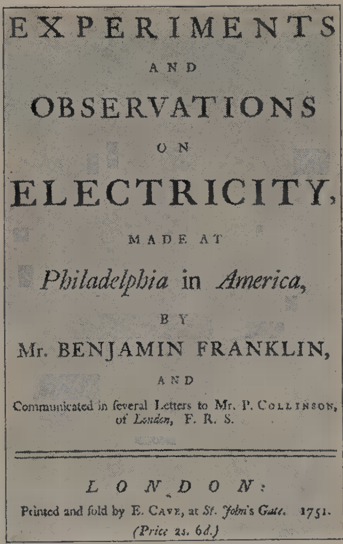
THE PHILOSOPHER AND HIS KITE

Benjamin Franklin, printer, philosopher, statesman and diplomat, was also a scientist. He made many experiments with electricity — the most famous being that with his epochal kite. Franklin, to prove his theory that lightning and electricity were identical, built a small kite of cedar strips covered with a large thin silk handkerchief, the latter to withstand the wind and rain of a thunderstorm. Projecting beyond the top of the kite, driven into the upper cedar arm was a long, sharp, pointed iron wire. Fearing a repetition of the experience of Von Kleist with the Leyden jar, Franklin hitched a silk ribbon to the end of the kite string to serve as a nonconductor and safeguard. At the junction of the cord and the ribbon, Franklin tied a large iron door key.

Upon the approach of a thunderstorm Franklin took his kite out of doors and flew it. To avoid the ribald jeers of his neighbors at seeing a middle-aged man flying a kite in a rainstorm Franklin made his small son accompany him and appear to take part in the sport.

Franklin at first got no results and was vastly disappointed, but upon the kite's flying into a black cloud he got an electric shock when he approached the key with his knuckle. Later, when the kite cord was thoroughly wet — water being an excellent electrical conductor — electricity ran down the cord and out at the key in a stream. Putting his proof into immediate practical use for mankind's benefit — as was his custom — Franklin started an agitation for the protection of buildings by means of lightning rods.

In later experiments Franklin completed the identification of lightning with electricity by proving that some clouds are positively charged and some negatively, just as is the case with electric "poles," and that the lightning flash leaps from cloud to cloud precisely as the spark jumps the gap between two "poles."



EXPERIMENTS

AND

OBSERVATIONS

ON

ELECTRICITY,

MADE AT

Philadelphia in *America*,

BY

Mr. BENJAMIN FRANKLIN,

AND

Communicated in several Letters to Mr. P. Collinson, of *London*, F. R. S.

LONDON:

Printed and sold by E. Cave, at *St. John's Gate*. 1751.

(Price 2s. 6d.)

336 From the first edition, London, 1751, in the United Engineering Societies Library, New York

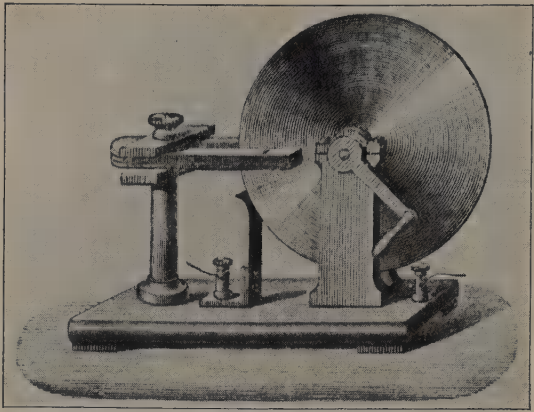
FRANKLIN'S WORK ON ELECTRICITY

Franklin, a good scientist, was also a good publicist, perhaps by reason of his trade as a printer. So he put his electrical researches into a book which first appeared in 1751. This gained him a world-wide audience.

MICHAEL FARADAY, INVENTOR OF THE DYNAMO

Michael Faraday, 1791–1867, a British scientist, was one of the most prominent experimenters in the whole history of electricity. His contributions to electrical knowledge cause his name to be revered among scientists along with Volta (volt), Ampère (ampere) and Ohm (ohm). In 1812 Faraday, then twenty-one years of age, seized an opportunity to hear a lecture by Sir Humphry Davy, the leading British scientist. Faraday was so interested that he sent Davy a copy of the notes he had taken on the lecture and asked to be employed by the master. The letter and notes must have impressed Davy for he gave Faraday a position as chemical assistant. Within seven years Faraday's researches and discoveries began to attract attention, and until his death in 1867, he continued to startle the scientific world with the results of his genius. But Faraday's fame rests chiefly upon his work with electricity. He did much to clear up the mysterious relation between magnetism and electricity, the induction of electric currents, and the creation of currents by motion of electric conductors in a magnetic field. The latter led to his dynamo, the first machine of its kind.

337 From a photograph given by Faraday to Cyrus W. Field, in the United States National Museum



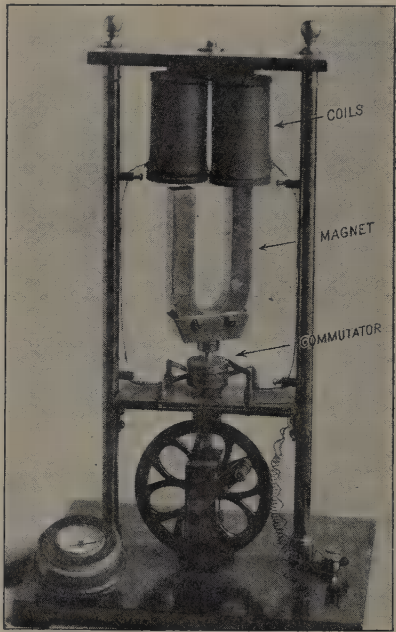
338 From Alglave and Boulard, *The Electric Light*, New York, 1884

FARADAY'S DYNAMO, 1831

Faraday on October 17, 1831, made the experiment of moving a permanent bar magnet in and out of a coil of wire attached to an electric indicator. The motion set up a current of electricity in the coil that was registered on the indicator. With this discovery Faraday hastened to construct a machine that would make his finding useful. In eleven days he had produced the first electric dynamo.

Before the dynamo, electric current was secured by frictional machines or from chemical reactions such as took place in the Voltaic pile or battery. Although large amounts of current could be obtained its cost was prohibitive except for endowed research.

A dynamo is a machine that changes mechanical energy into electrical energy, just as a boiler changes the heat energy of coal into the expansive energy of steam, or as the steam engine turns the expansive energy of steam into mechanical energy. Some form of energy must be used to run a dynamo; this may be human muscle, a steam engine or a water wheel. If electric current is the motive force of a dynamo, then the latter is not a dynamo at all but an electric motor. Thus the same machine, with some adjustments, may be used either as a dynamo or an electric motor.



339 From a full-sized replica in the United States Natural Museum

PIXII'S DYNAMO, 1832

Although Faraday himself did nothing further with his dynamo, such a discovery could not go undeveloped in the scientific world. A Frenchman named Hippolyte Pixii worked with Faraday's dynamo until in 1832 he produced a new variety. In Faraday's machine the magnet was fixed, and an electric conductor moved past it; Pixii reversed this practice and moved a magnet past an electrical conductor.

Dynamos produce a current that fluctuates — called "alternating." For many kinds of electrical work a steady current is best, so dynamos must be so arranged that their alternating currents may be changed into direct currents. The commutator upon a dynamo does this work. Pixii's dynamo possessed a commutator, a significant contribution. The dynamo was a momentous step in the development of electricity for general use in everyday life. It is one of those inventions upon which, like a foundation, rests a vast superstructure of correlated devices.

340 Head and bust of the Henry statue by W. W. Story (1819–95), in the grounds of the Smithsonian Institution, Washington

JOSEPH HENRY, 1797–1878

The first American after Franklin to gain eminence as an electrical experimenter was Joseph Henry. Born in Albany, New York, he attended Albany Academy, and became a teacher there. Henry made an intensive study of magnets and magnetism, and invented some small electromagnets. He next showed that a core of iron could be electrically magnetized from a distance. This he demonstrated with an electric bell, the first one in the world. The importance of the discovery, however, was not its usefulness for bells but in telegraphy and telephony which came later. A statue in his honor was erected in the grounds of the Smithsonian Institution, of which he had been the first secretary and director.

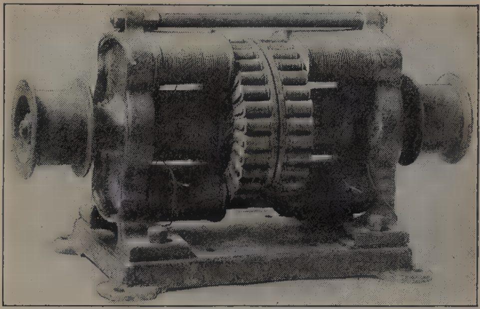
341 Courtesy of the American Telephone and Telegraph Company, New York

MOSES G. FARMER, 1820–93

The dynamo, like the electric cell, was the work of a succession of men who little by little added to the precision of the machine. In America the first patent for a dynamo was issued to Moses G. Farmer in 1875. Farmer was also the first man to carry passengers upon an electric railway. He invented, besides, the first telegraphic fire alarm, the first thermoelectric battery, and the first automatic system of electric lighting.

WALLACE–FARMER DYNAMO, 1875

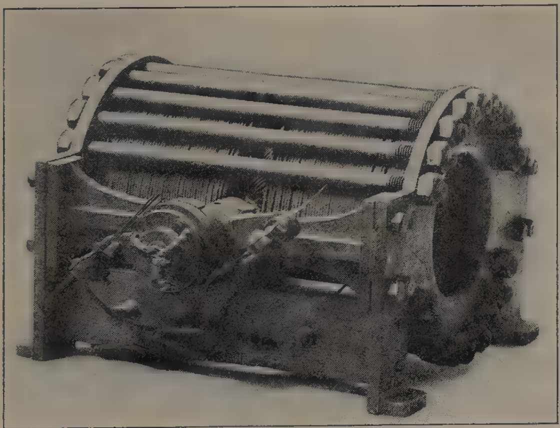
Farmer constructed a dynamo that produced the current which lighted portions of the buildings at the Philadelphia Centennial (1876). In making this dynamo Farmer was associated with William Wallace, an Englishman by birth, who resided in Ansonia, Connecticut. A national authority on copper, zinc and tin, Wallace invented an electric wire with a steel core and an electric-plated copper covering. The core gave strength and lightness while the plating gave electric conductivity. He was also the inventor of an arc lamp. The Wallace-Farmer dynamo was really two in one. The armature consisted of a number of bobbins, all connected in an endless ring and each joined by wire to a commutator bar. There were two sets of bobbins and two commutators and two electric magnets. Each half of the dynamo could be used to run different circuits or they could be joined to form one powerful dynamo.



342 From the original in the United States National Museum

THOMSON–HOUSTON ARC DYNAMO, 1878

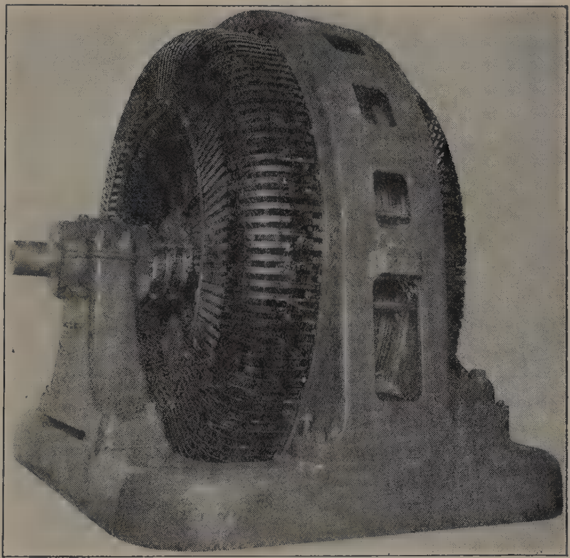
Elihu Thomson and Edwin J. Houston in 1878 produced a dynamo (No. 343) that for many years was the standard equipment in electric lighting stations. This dynamo contained one improvement of importance; it was self-regulating. If the number of lamps burning at one time changed, the resulting shift in the load upon the dynamo was compensated within the dynamo and an even flow of current was maintained.



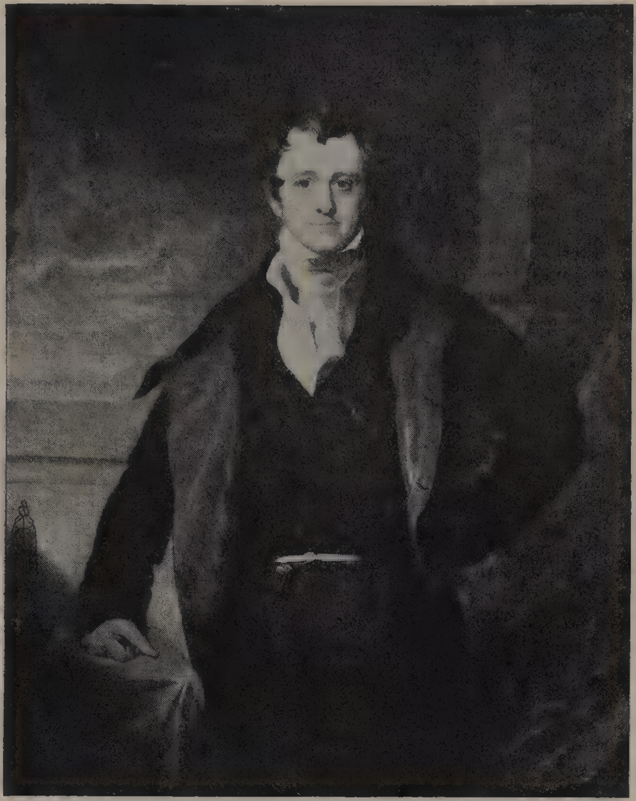
343 From the original in the United States National Museum

A MODERN DYNAMO

Modern dynamos are of all sizes, from tiny affairs actuated by the water power of a farmer's brook to machines of enormous capacity such as those in the lighting plants of New York City, where the dynamo is operated by a giant steam turbine. Small or large, dynamos all have a family resemblance; the circular form, the coils of wire, the commutator bars and the rigid iron or steel shell all look alike despite their differences in size.



344 Courtesy of the General Electric Company



345 From the portrait after Sir Thomas Lawrence (1769–1830), in the National Portrait Gallery, London

SIR HUMPHRY DAVY, 1778–1829

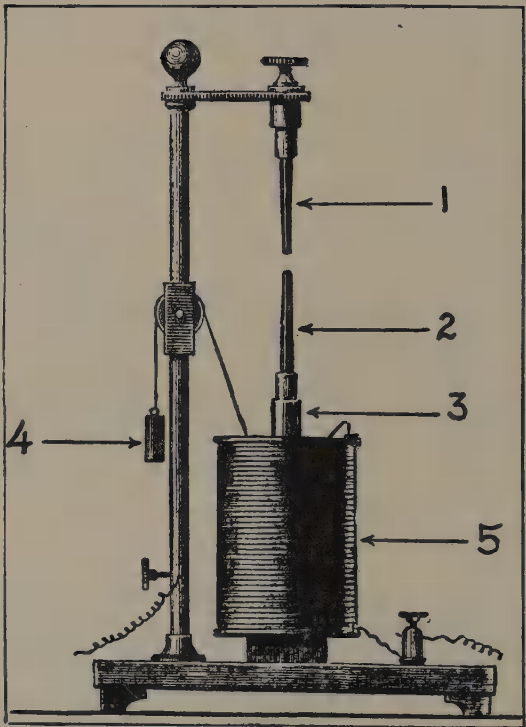
Most of the efforts to produce illumination by means of electricity have been confined to two types of devices; one the electric arc, the other the incandescent lamp.

About 1809 an English chemist, Humphry Davy, demonstrated that an electric spark could be maintained for a long time by connecting two sticks of charcoal by wires to the positive and negative terminals of a powerful battery. Gradually separating the two sticks until they were about three inches apart, he found that the current, instead of ceasing when the contact between the charcoals was broken, continued to flow across the space between the two sticks. In doing so, part of the charcoal was heated and converted into a brilliant flame. Davy called this flame an "arc" because the heated gases in rising assumed an arch shape. This experiment began the development of the electric arc light. Davy's arc light was but one of the triumphs of a life of distinguished scientific service which won him first the honor of knighthood and later that of baronet.

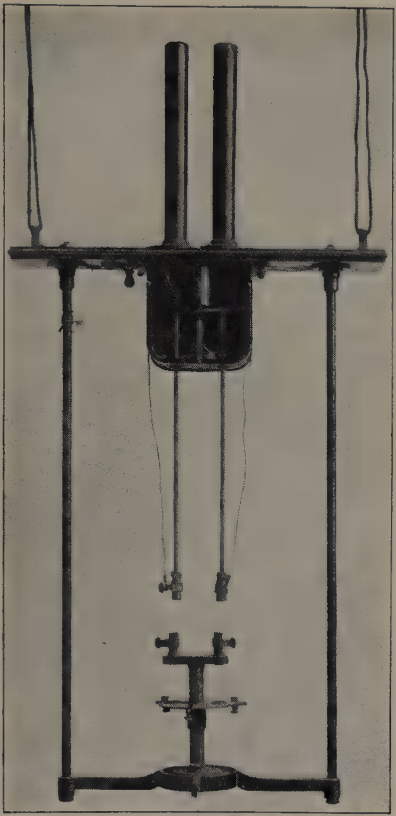
ARCHEREAU'S ARC LAMP, 1848

Following Davy's demonstration of the electric arc, wide experimentation led to the discovery that most of the light of the arc came from the tip of the positive charcoal stick, and that although both sticks were rapidly consumed the positive burned away about twice as fast as the negative. The next step was to design mechanisms that would take care of this difference in wear in the two sticks, and also to bring the two sticks together to start the arc and then keep them separated a proper distance.

The first partly successful automatic arc lamp was made by Archereau, a Frenchman, in 1848. In his lamp he placed the carbons one above the other; the upper or negative carbon (1) being fixed, and the lower or positive carbon (2) mounted on a piece of iron (3) so arranged that the iron could be drawn downward inside a coil of wire (5). The weight of the lower positive carbon was balanced by a weight (4) so that when no current was flowing the two carbons would touch. When the current was turned on it flowed through the two carbons and also through the coil of wire (5). This was then magnetized and drew down the iron (3) and with it the lower carbon (2). The separation of the two carbons created the arc. When the current ceased or the arc broke, the magnetic action of the coil (5) also stopped and the counterweight (4) drew the lower carbon back into contact with the upper one.



346 From Hippolyte Fontaine, *Éclairage à l'Électricité*, Paris, 1879



347 From the original patent office model in the United States National Museum

BRUSH'S ARC LAMP, 1877

THE first notable commercial success in America with arc lighting was with automatically controlled lamps invented by Charles J. Brush in 1877. Brush was by no means the first man to set up arc lamps commercially, but his enjoyed long popularity. Brush's lamps were not only automatically controlled but had two pairs of carbons so that the lamps could burn all night. Each set of carbons burned for about eight hours. When the first pair was consumed a simple automatic switch diverted the current to the other pair.

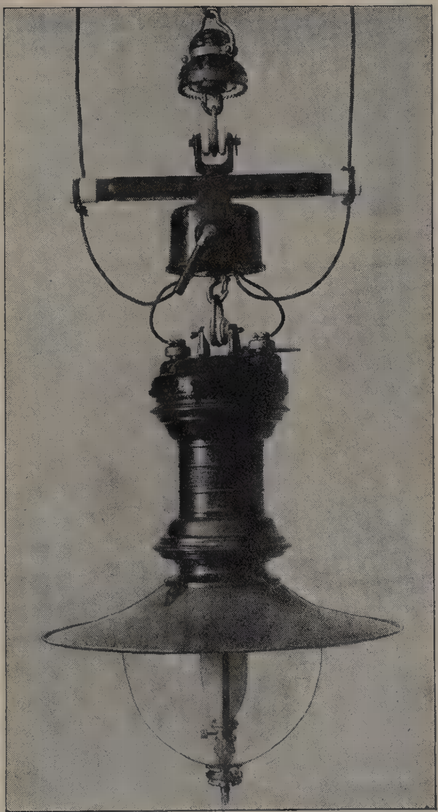
348 A New York Street Lighted by Brush Lamps, from Alglave and Boulard, *The Electric Light*, New York, 1884

ENCLOSED ARC LAMP, 1893

BEGINNING in 1880 several arc light systems were developed into commercial successes; but no radical improvement in the lamp itself was made until 1893. Before that year all the arc lamps were arranged to burn their carbons in the open air. This meant that the carbons were rapidly consumed, lasting at the most only sixteen hours. Men were employed to visit every arc lamp daily to change the carbons; this was an expense and a nuisance.

In 1893 an American, Louis B. Marks, found that he could prolong the life of the carbons from ten to twelve times if he put a light globe about the arc. The globe shut off the air and by reducing the amount of oxygen in contact with the hot carbons caused them to burn more slowly. Although the enclosure slightly reduced the amount of light it was more than warranted by the saving in lamp tenders.

The arc light brought a revolution to city streets. The feeble gas light disappeared from the busy central thoroughfares and the flaring, sputtering arc was suspended in its stead. New York theater crowds hurrying to and from the metropolitan playhouses in the latter decades of the nineteenth century watched the advent of the new era of light and commented on this triumph of human inventive skill. The day of the arc light has not passed. But many persons who, in the 'eighties and 'nineties, watched with astonishment and admiration the coming of electric lighting have lived to see the flickering arc light give place to the brilliant illumination of the modern "White Way."



349 Courtesy of the General Electric Company

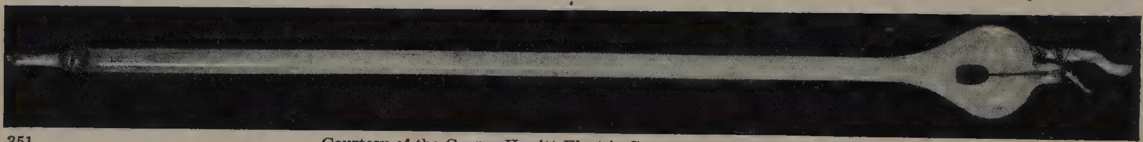
IMPROVEMENTS IN ARC LAMPS

The arc light was further improved in 1898 by mixing various salts with the carbons when the pencils were manufactured. When burned these salts produced a flame which greatly increased luminosity. The first flaming arcs were open to the air in order to get rid of the smoke of the burning salts; but in 1908 a chamber was added to the lamp in which the smoke could be condensed. This permitted enclosing the carbons with the same savings previously obtained by this method. So the arc lamp was perfected to make possible its use under all kinds of conditions.

350 Enclosed Flame Arc Lamp, 1908, courtesy of the General Electric Company

COOPER-HEWITT MERCURY VAPOR ARC LAMP, 1901

Although electrical experimenters had known since 1860 that if an electric circuit was opened between mercury contacts a peculiar bright greenish arc was produced, no commercial use was made of the knowledge until 1901 when Dr. Peter Cooper Hewitt placed his mercury vapor arc lamp on the market. Hewitt after many experiments eventually produced an arc in vacuum in a one-inch glass tube about fifty inches long. The tube was hung so that its length was but slightly tilted off the horizontal. A lower end contained a slight quantity of mercury which, when the tube was tilted, made a thin mercury bridge across the electric terminals at each end of the tube. The current turned this mercury into gas and in doing so formed an arc. The commercial lamp was provided with mechanisms which tilted the tube automatically to start the arc. The lamp has proved valuable because it has no red rays and is therefore useful for photography, printing offices, freight houses and other places where a light of high actinic value is desired. The light also is highly diffused and so avoids glare and dissipates shadows.



351 Courtesy of the Cooper-Hewitt Electric Company, Hoboken, N. J.

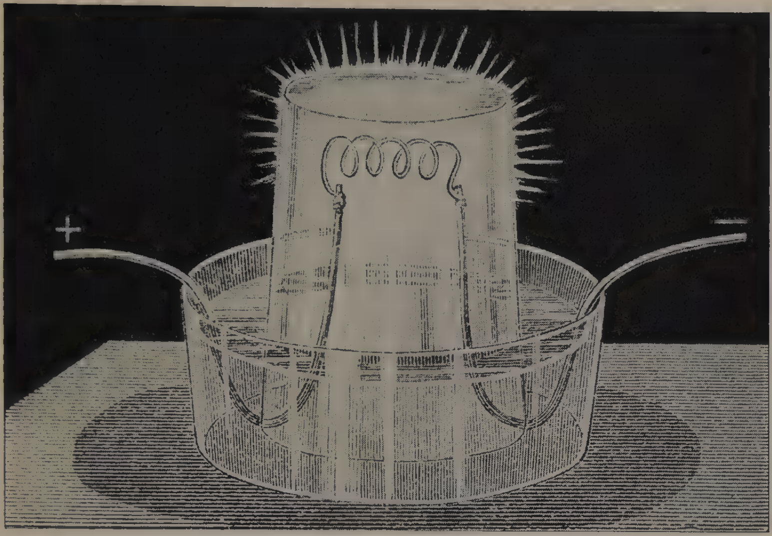
THE MOORE TUBE LIGHT

Another tube light is that known as the Moore tube. D. McFarlan Moore, an American, began to experiment with vacuum tubes in 1891 but it was not until 1904 that he constructed a lamp with commercial possibilities.

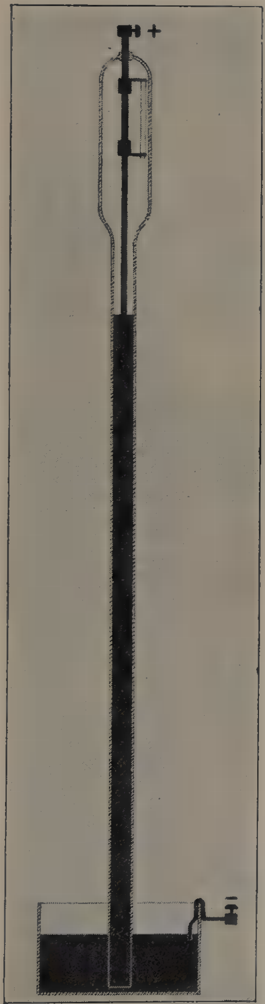
The first commercial Moore tube light was set up in a hardware store in Newark, New Jersey. It consisted of a glass tube $1\frac{3}{4}$ inches in diameter and 180 feet long. As may be seen from the illustration, the tube was made to conform to the long narrow shape of the store it served. The tube contained a slight amount of air under a tiny amount of pressure. When an electric current was passed through the tube it glowed with a faintly pink color.

352 First installation of the Moore tube light in a store in Newark, N. J., courtesy of D. McFarlan Moore

A more pleasing and efficient light was obtained when the tube contained nitrogen gas. This gave a yellow light. Carbon dioxide gas rendered a pure white light. The latter light was a close approximation of daylight and was highly useful where color matching was required. Indeed this is practically the only use now made of the Moore tube, for the incandescent light has surpassed it for nearly every other purpose.



353 From Franklin L. Pope, *Evolution of the Electric Incandescent Lamp*, Elizabeth, N.J., 1889



354 From a diagram, courtesy of the Edison Lamp Works, Harrison, N.J.

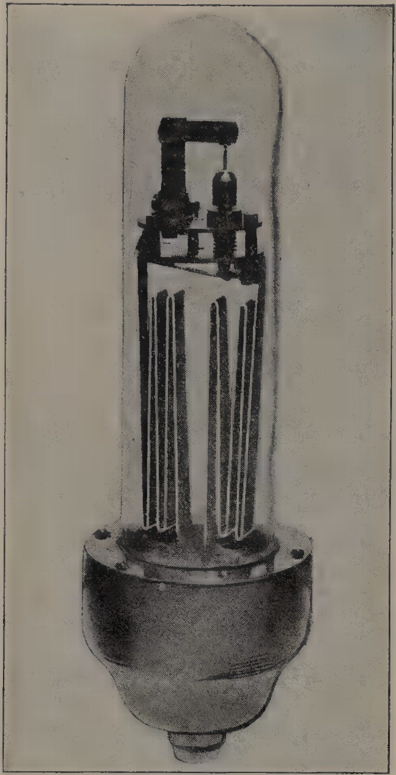
GROVE'S INCANDESCENT LAMP, 1840

One of the first experiments with incandescent light was made by Sir William Robert Grove, an English judge and scientist, in 1840. He attached the ends of a coil of platinum wire to copper wires, the lower sections of which were varnished for insulation. The platinum wire was covered with a drinking glass turned down in a dish partly filled with water. The purpose of this arrangement was to protect the glowing platinum from cooling currents of air. Although Grove lighted lecture halls with his device, it gave only a feeble light. Since the source of the current was a battery or batteries the cost, approximately several hundred dollars an hour, was prohibitive for commercial installation. It was one of the earliest steps in producing the lighting device that has become commonplace in modern times.

STARR'S INCANDESCENT LAMP, 1845

J. A. Starr, of Cincinnati, is credited with introducing the idea of electrically heating a metallic substance in a vacuum in order to produce an incandescent light. He borrowed from the barometer a long glass tube enlarged at its upper closed end, filled it with mercury and inserted the open end in a dish of mercury. The mercury of the tube, as in a barometer, sank within the tube until the weight of the column of mercury was counterbalanced by the pressure of the atmosphere upon the mercury in the dish. The sinking of the mercury in the tube left a vacuum at the enlarged upper closed end of the tube. In this space was a rod of carbon clamped with iron at the top to a heavy platinum wire which was in turn sealed into the upper end of the glass tube. The lower end of the carbon rod was held by another iron clamp attached to a nonconducting porcelain rod. This rod was kept in place by another iron clamp to which was attached a long copper wire extending down the tube into the mercury. Electric current passed into the upper enlarged portion of the tube through the platinum wire, thence through the carbon, then the copper wire, and out by way of the mercury, the liquid serving as an electric pole.

These lamps were exhibited in London, but failed commercially because they blackened rapidly. Scientifically, however, the light paved the way for better ones operated upon similar principles. The inventor Starr died on board ship, at the age of twenty-five years, when he was returning home from demonstrating his lamps in London.

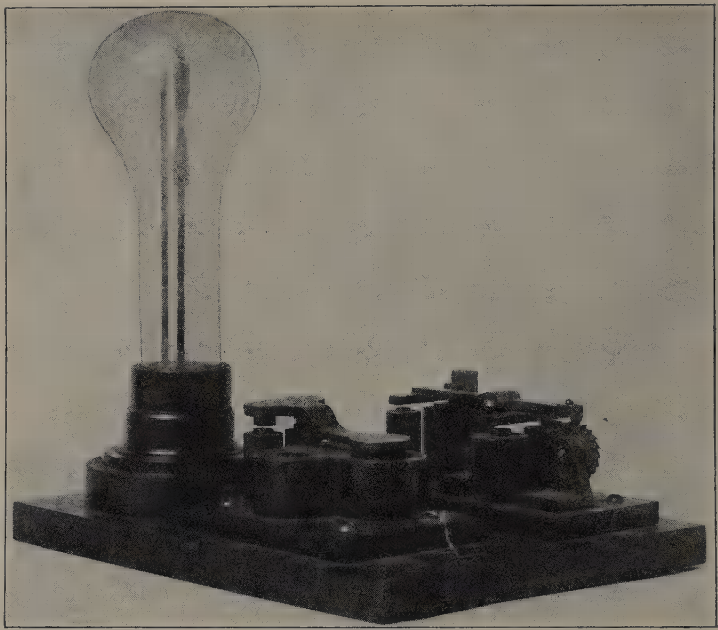


355 Courtesy of the Edison Lamp Works

SAWYER'S INCANDESCENT LAMP, 1878

Following Starr's lamp considerable work was done by Europeans to improve the incandescent lamp, but it was ignored in America until the late 'seventies and early 'eighties, when four American inventors turned to the incandescent lamp and brought it into the realm of practical everyday things. These men were William E. Sawyer, Moses G. Farmer, Hiram S. Maxim and Thomas A. Edison.

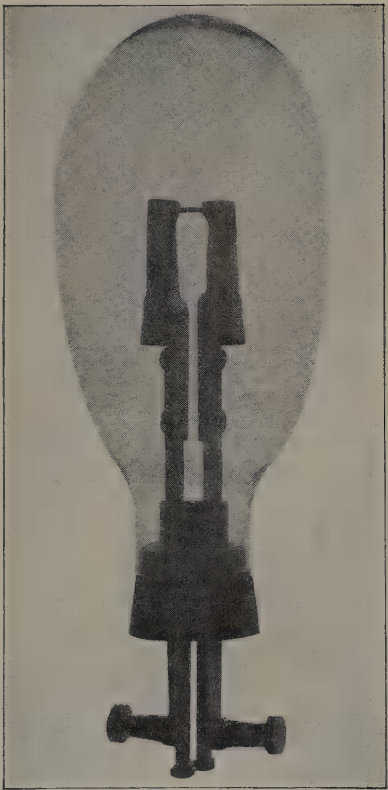
In 1878, Sawyer made a lamp that followed closely upon European models. It consisted of a thick carbon burner operating in nitrogen gas. It had a long glass tube closed at one end and cemented on the other end to a brass base through which the gas was admitted. Heavy wires within the tube connected with the base in order to carry away the heat of the burner which was attached to the upper end of the wire. The burner could be renewed when burned out.



356 From the original patent office model, 1878, in the United States National Museum

MAXIM'S INCANDESCENT LAMP, 1878

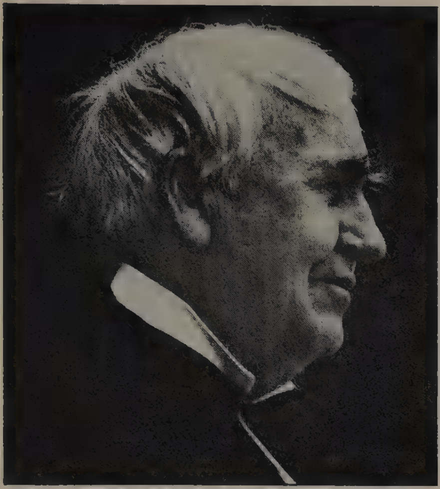
Maxim's incandescent lamp (No. 356) comprised a glass bulb, which was filled, however, with rarefied hydrocarbon vapor instead of nitrogen gas. His burner, like Sawyer's, was made of carbon. Maxim made another incandescent lamp that dispensed with the glass bulb and its gas filler, and simply consisted of a sheet of platinum operating in air. Farmer, too, as early as 1859, had made an incandescent lamp like this.



357 From the original in the United States National Museum

FARMER'S INCANDESCENT LAMP, 1878

Moses G. Farmer's incandescent lamp (No. 357) was somewhat like Sawyer's in that he used a nitrogen gas filled bulb. The rest of the lamp, however, was different. His burner was a graphite rod. This was suspended between two heavy copper rods set in a rubber plug at the base of the bulb.



358 From a photograph by John E. Garabrant

THOMAS ALVA EDISON, 1847–

Although the work of Sawyer, Farmer, and Maxim shows how wide was the interest in incandescent lighting, the commercially successful electric light owes its existence to the experiments of Thomas A. Edison. As a boy Edison had rescued a child, daughter of a station master, from death under the train wheels and in gratitude the father taught him telegraphy. Edison then set up a private telegraph line of his own but was soon bought out by the Western Union Telegraph Company, which employed him as operator at Stratford, Canada, on the Grand Trunk Railway; but he did not hold this job and for several years was virtually a tramp telegrapher.

359 Edison in 1878, from a photograph in possession of the publishers

His wanderings finally took Edison, in 1871, to New York. He was then 24 and was on the ground when an accident stopped the service of the Gold and Stock Company — a "ticker" service in the financial district. Edison volunteered to straighten out the difficulty, and succeeding in this, he was at once given a permanent position. Putting his ideas to work for the company, he rose rapidly in rank. When he succeeded in perfecting a long held idea of duplex and later, quadruplex, telegraphy, his troubles were over. The Gold and Stock Company, together with the Western Union Company, turned him loose to invent, paying him a salary, bearing his expenses and underwriting his inventions when made.

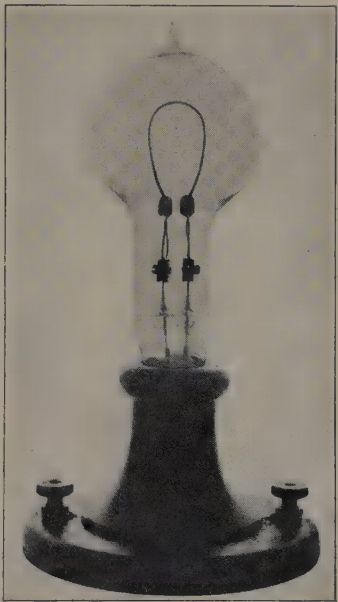
From that day to this ideas, experiments and inventions have continued to flow from Edison's laboratory, first at Menlo Park, New Jersey, later the larger establishment at West Orange, New Jersey. At the outset of this phase of his career, Edison attempted to manufacture the devices he invented; but he soon learned that he could not be both an inventor and a manufacturer. So his ideas were all turned over to the Edison General Electric Company for commercial exploitation.

EDISON'S CARBON LAMP, OCTOBER 21, 1879

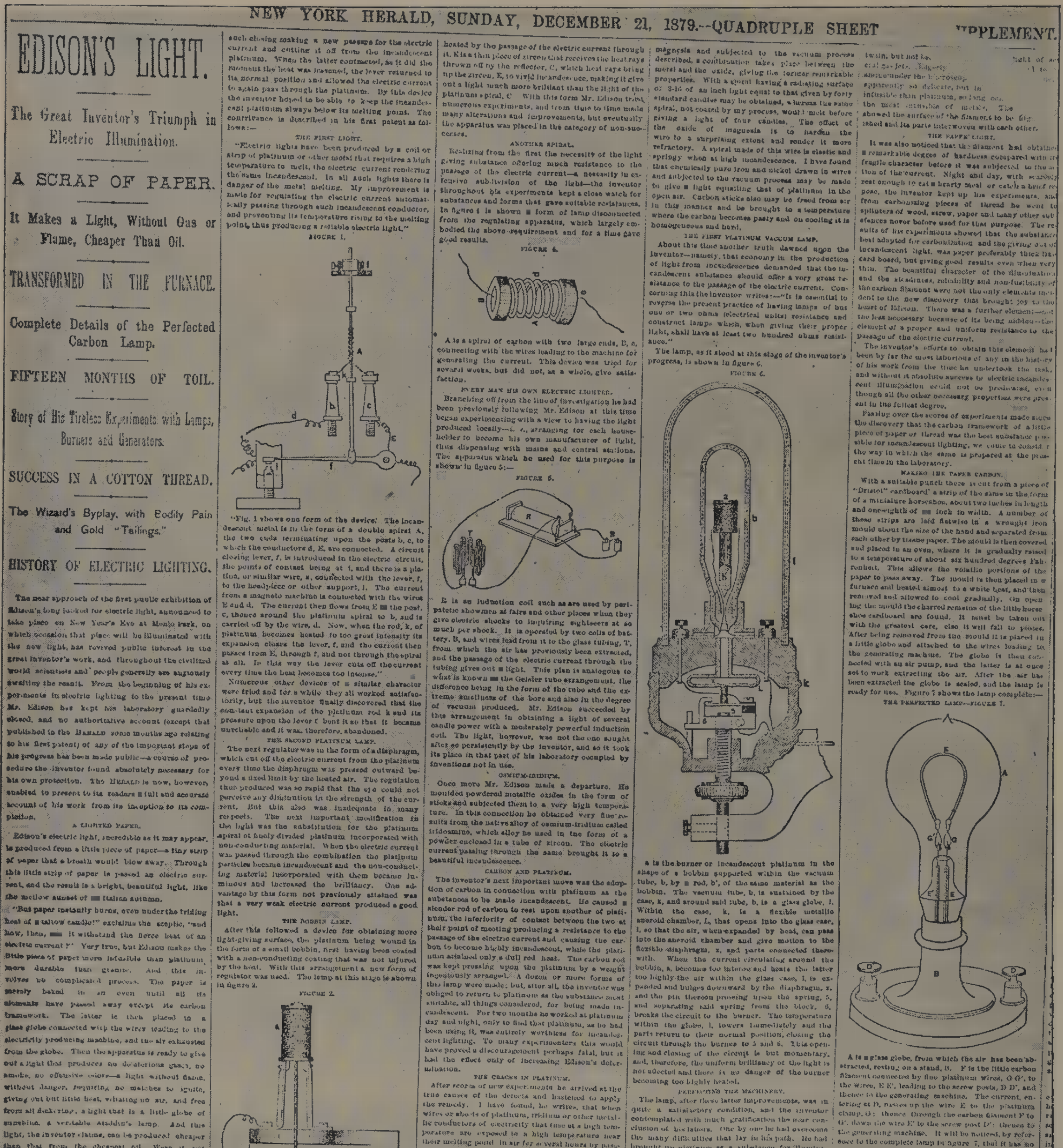
By the time Edison began to experiment with the incandescent light, he was well known as the inventor of the phonograph and the improver of many electrical devices connected with telegraphy and telephony. He had a well equipped laboratory at Menlo Park, and about 100 assistants of different grades.

Following in the path of Sawyer, Farmer and Maxim, Edison produced lamps somewhat like theirs but with superior features which he patented. Realizing that the value of a lamp, however good, was limited for domestic use because electric current as then distributed did not permit the turning on and off of individual lamps, Edison attacked the fundamental problems of the generation and distribution of electric current. These he solved by producing a new kind of dynamo, together with a new way of distributing electric energy which permitted lamps to be operated independently.

With the first step taken, Edison was ready to experiment with a new kind of incandescent lamp. After many trials he finally hit upon a lamp that consisted of an all-glass globe in which was a high vacuum. In this globe he fixed a slender piece of highly resistant carbon, which he obtained by carbonizing a piece of sewing thread. Platinum wires were fused in the glass globe, connecting the ends of the carbonized thread with an electric circuit outside the globe. Platinum was chosen because it has the same expansion as glass and therefore rendered the glass globe air-tight. Current was turned into the lamp on October 21, 1879. It was a success.



360 From a replica in the United States National Museum



NEW YORK HERALD, SUNDAY, DECEMBER 21, 1879.--QUADRUPLE SHEET ... PPLEMENT.

EDISON'S LIGHT.

The Great Inventor's Triumph in Electric Illumination.

A SCRAP OF PAPER.

It Makes a Light, Without Gas or Flame, Cheaper Than Oil.

TRANSFORMED IN THE FURNACE.

Complete Details of the Perfected Carbon Lamp.

FIFTEEN MONTHS OF TOIL.

Story of His Tireless Experiments with Lamps, Burners and Generators.

SUCCESS IN A COTTON THREAD.

The Wizard's Byplay, with Bodily Pain and Gold "Tailings."

HISTORY OF ELECTRIC LIGHTING.

The near approach of the first public exhibition of Edison's long looked for electric light, announced to take place on New Year's Eve at Menlo Park, on which occasion that place will be illuminated with the new light, has revived public interest in the great inventor's work, and throughout the civilized world scientists and people generally are anxiously awaiting the result. From the beginning of his experiments in electric lighting to the present time Mr. Edison has kept his laboratory guardedly closed, and no authoritative account (except that published in the HERALD some months ago relating to his first patent) of any of the important steps of his progress has been made public—a course of procedure the inventor found absolutely necessary for his own protection. The HERALD is now, however, enabled to present to its readers a full and accurate account of his work from its inception to its completion.

A LIGHTED PAPER.

Edison's electric light, incredible as it may appear, is produced from a little piece of paper—a tiny strip of paper that a breath would blow away. Through this little strip of paper is passed an electric current, and the result is a bright, beautiful light, like the mellow sunset of an Italian autumn.

"But paper instantly burns, even under the trifling heat of a tallow candle!" exclaims the sceptic, "and how, then, can it withstand the fierce heat of an electric current?" Very true, but Edison makes the little piece of paper more infusible than platinum, more durable than granite. And this involves no complicated process. The paper is merely baked in an oven until all its elements have passed away except its carbon framework. The latter is then placed in a glass globe connected with the wires leading to the electricity producing machine, and the air exhausted from the globe. Then the apparatus is ready to give out a light that produces no deleterious gases, no smoke, no offensive odors—a light without flame, without danger, requiring no matches to ignite, giving out but little heat, vitiating no air, and free from all flickering; a light that is a little globe of sunshine, a veritable Aladdin's lamp. And this light, the inventor claims, can be produced cheaper than that from the cheapest oil. Were it not for the phonograph, the quadruplex telegraph, the telephone and the various other remarkable productions of the great inventor the world might well hesitate to accept his assurance

such closing making a new passage for the electric current and cutting it off from the incandescent platinum. When the latter contracted, as it did the moment the heat was lessened, the lever returned to its normal position and allowed the electric current to again pass through the platinum. By this device the inventor hoped to be able to keep the incandescent platinum always below its melting point. The contrivance is described in his first patent as follows:—

THE FIRST LIGHT.

"Electric lights have been produced by a coil or strip of platinum or other metal that requires a high temperature to melt, the electric current rendering the same incandescent. In all such lights there is danger of the metal melting. My improvement is made for regulating the electric current automatically passing through such incandescent conductor, and preventing its temperature rising to the melting point, thus producing a reliable electric light."

FIGURE 1.

"Fig. 1 shows one form of the device: The incandescent metal is in the form of a double spiral A, the two ends terminating upon the posts b, c, to which the conductors d, E are connected. A circuit closing lever, f, is introduced in the electric circuit, the points of contact being at f, and there is a platina, or similar wire, g, connected with the lever, f, to the head-piece or other support, l. The current from a magneto machine is connected with the wires E and d. The current then flows from E to the post, c, thence around the platinum spiral to b, and is carried off by the wire, d. Now, when the rod, k, of platinum becomes heated to too great intensity its expansion closes the lever, f, and the current then passes from E, through f, and not through the spiral at all. In this way the lever cuts off the current every time the heat becomes too intense."

Numerous other devices of a similar character were tried and for a while they all worked satisfactorily, but the inventor finally discovered that the constant expansion of the platinum rod k and its pressure upon the lever f bent it so that it became unreliable and it was, therefore, abandoned.

THE SECOND PLATINUM LAMP.

The next regulator was in the form of a diaphragm, which cut off the electric current from the platinum every time the diaphragm was pressed outward beyond a fixed limit by the heated air. The regulation thus produced was so rapid that the eye could not perceive any diminution in the strength of the current. But this also was inadequate in many respects. The next important modification in the light was the substitution for the platinum spiral of finely divided platinum incorporated with non-conducting material. When the electric current was passed through the combination the platinum particles became incandescent and the non-conducting material incorporated with them became luminous and increased the brilliancy. One advantage by this form not previously attained was that a very weak electric current produced a good light.

THE BOBBIN LAMP.

After this followed a device for obtaining more light-giving surface, the platinum being wound in the form of a small bobbin, first having been coated with a non-conducting coating that was not injured by the heat. With this arrangement a new form of regulator was used. The lamp at this stage is shown in figure 2.

FIGURE 2.

heated by the passage of the electric current through it. K is a thin piece of zircon that receives the heat rays thrown off by the reflector, C, which heat rays bring up the zircon, E, to vivid incandescence, making it give out a light much more brilliant than the light of the platinum spiral, C. With this form Mr. Edison tried numerous experiments, and from time to time made many alterations and improvements, but eventually the apparatus was placed in the category of non-successes.

ANOTHER SPIRAL.

Realizing from the first the necessity of the light giving substance offering much resistance to the passage of the electric current—a necessity in extensive subdivision of the light—the inventor throughout his experiments kept a close watch for substances and forms that gave suitable resistances. In figure 4 is shown a form of lamp disconnected from the regulating apparatus, which largely embodied the above requirement and for a time gave good results.

FIGURE 4.

A is a spiral of carbon with two large ends, B, a, connecting with the wires leading to the machine for generating the current. This device was tried for several weeks, but did not, as a whole, give satisfaction.

EVERY MAN HIS OWN ELECTRIC LIGHTER.

Branching off from the line of investigation he had been previously following Mr. Edison at this time began experimenting with a view to having the light produced locally—i. e., arranging for each householder to become his own manufacturer of light, thus dispensing with mains and central stations. The apparatus which he used for this purpose is shown in figure 5:—

FIGURE 5.

R is an induction coil such as are used by peripatetic showmen at fairs and other places when they give electric shocks to inquiring sightseers at so much per shock. It is operated by two cells of battery, B, and wires lead from it to the glass tubing, T, from which the air has previously been extracted, and the passage of the electric current through the tubing gives out a light. This plan is analogous to what is known as the Geisler tube arrangement, the difference being in the form of the tube and the extreme smallness of the bore and also in the degree of vacuum produced. Mr. Edison succeeded by this arrangement in obtaining a light of several candle power with a moderately powerful induction coil. The light, however, was not the one sought after so persistently by the inventor, and so it took its place in that part of his laboratory occupied by inventions not in use.

OSMIUM-IRIDIUM.

Once more Mr. Edison made a departure. He moulded powdered metallic oxides in the form of sticks and subjected them to a very high temperature. In this connection he obtained very fine results from the native alloy of osmium-iridium called iridosmine, which alloy he used in the form of a powder enclosed in a tube of zircon. The electric current passing through the same brought it to a beautiful incandescence.

CARBON AND PLATINUM.

The inventor's next important move was the adoption of carbon in connection with platinum as the substances to be made incandescent. He caused a slender rod of carbon to rest upon another of platinum, the inferiority of contact between the two at their point of meeting producing a resistance to the passage of the electric current and causing the carbon to become highly incandescent, while the platinum attained only a dull red heat. The carbon rod was kept pressing upon the platinum by a weight ingeniously arranged. A dozen or more forms of this lamp were made; but, after all, the inventor was obliged to return to platinum as the substance most suitable, all things considered, for being made incandescent. For two months he worked at platinum day and night, only to find that platinum, as he had been using it, was entirely worthless for incandescent lighting. To many experimenters this would have proved a discouragement perhaps fatal, but it had the effect only of increasing Edison's determination.

THE CRACKS IN PLATINUM.

After scores of new experiments he arrived at the true causes of the defects and hastened to apply the remedy. I have found, he writes, that when wires or sheets of platinum, iridium or other metallic conductors of electricity that fuse at a high temperature are exposed to a high temperature near their melting point in air for several hours by passing a current of electricity through them and then are allowed to cool, the metal is found to be ruptured, and under the microscope there are revealed myriads of cracks in various directions, many of which reach nearly to the centre of the wire. I have also discovered that, contrary to the received notion,

magnesia and subjected to the vacuum process described, a combination takes place between the metal and the oxide, giving the former remarkable properties. With a spiral having a radiating surface of 3-16 of an inch light equal to that given by forty standard candles may be obtained, whereas the same spiral, not coated by my process, would melt before giving a light of four candles. The effect of the oxide of magnesia is to harden the wire to a surprising extent and render it more refractory. A spiral made of this wire is elastic and springy when at high incandescence. I have found that chemically pure iron and nickel drawn in wires and subjected to the vacuum process may be made to give a light equalling that of platinum in the open air. Carbon sticks also may be freed from air in this manner and be brought to a temperature where the carbon becomes pasty and on cooling it is homogeneous and hard.

THE FIRST PLATINUM VACCUM LAMP.

About this time another truth dawned upon the inventor—namely, that economy in the production of light from incandescence demanded that the incandescent substance should offer a very great resistance to the passage of the electric current. Concerning this the inventor writes:—"It is essential to reverse the present practice of having lamps of but one or two ohms (electrical units) resistance and construct lamps which, when giving their proper light, shall have at least two hundred ohms resistance."

The lamp, as it stood at this stage of the inventor's progress, is shown in figure 6.

FIGURE 6.

a is the burner or incandescent platinum in the shape of a bobbin supported within the vacuum tube, b, by a rod, b', of the same material as the bobbin. The vacuum tube, b, is sustained by the case, k, and around said tube, b, is a glass globe, l. Within the case, k, is a flexible metallic aneroid chamber, L, that opens into the glass case, l, so that the air, when expanded by heat, can pass into the aneroid chamber and give motion to the flexible diaphragm, x, and parts connected therewith. When the current circulating around the bobbin, a, becomes too intense and heats the latter too highly the air within the glass case, l, is expanded and bulges downward by the diaphragm, x, and the pin thereon pressing upon the spring, 5, and separating said spring from the block, 6, breaks the circuit to the burner. The temperature within the globe, l, lowers immediately and the parts return to their normal position, closing the circuit through the burner to 5 and 6. This opening and closing of the circuit is but momentary, and, therefore, the uniform brilliancy of the light is not affected and there is no danger of the burner becoming too highly heated.

PERFECTING THE MACHINERY.

The lamp, after these latter improvements, was in quite a satisfactory condition, and the inventor contemplated with much gratification the near conclusion of his labors. One by one he had overcome the many difficulties that lay in his path. He had brought up platinum as a substance for illumination from a state of comparative worthlessness to one well nigh perfection. He had succeeded, by a curious combination and improvement in air pumps, in obtaining a vacuum of nearly one millionth of an atmosphere, and he had perfected a generator or electricity producing machine (for all the

twain, but not la... eral gas jets. Eagerly ... amine under the microscope, apparently so delicate, but in infusible than platinum, so long ... the most infusible of metals. The ... showed the surface of the filament to be highly ... ished and its parts interwoven with each other.

THE PAPER LIGHT.

It was also noticed that the filament had obtained a remarkable degree of hardness compared with its fragile character before it was subjected to the action of the current. Night and day, with scarcely rest enough to eat a hearty meal or catch a brief repose, the inventor kept up his experiments, and from carbonizing pieces of thread he went to splinters of wood, straw, paper and many other substances never before used for that purpose. The results of his experiments showed that the substance best adapted for carbonization and the giving out of incandescent light, was paper preferably thick like card board, but giving good results even when very thin. The beautiful character of the illumination and the steadiness, reliability and non-fusibility of the carbon filament were not the only elements incident to the new discovery that brought joy to the heart of Edison. There was a further element—not the less necessary because of its being hidden—the element of a proper and uniform resistance to the passage of the electric current.

The inventor's efforts to obtain this element had been by far the most laborious of any in the history of his work from the time he undertook the task, and without it absolute success in electric incandescent illumination could not be predicated, even though all the other necessary properties were present in the fullest degree.

Passing over the scores of experiments made since the discovery that the carbon framework of a little piece of paper or thread was the best substance possible for incandescent lighting, we come to consider the way in which the same is prepared at the present time in the laboratory.

MAKING THE PAPER CARBON.

With a suitable punch there is cut from a piece of "Bristol" cardboard a strip of the same in the form of a miniature horseshoe, about two inches in length and one-eighth of an inch in width. A number of these strips are laid flatwise in a wrought iron mould about the size of the hand and separated from each other by tissue paper. The mould is then covered and placed in an oven, where it is gradually raised to a temperature of about six hundred degrees Fahrenheit. This allows the volatile portions of the paper to pass away. The mould is then placed in a furnace and heated almost to a white heat, and then removed and allowed to cool gradually. On opening the mould the charred remains of the little horseshoe cardboard are found. It must be taken out with the greatest care, else it will fall to pieces. After being removed from the mould it is placed in a little globe and attached to the wires leading to the generating machine. The globe is then connected with an air pump, and the latter is at once set to work extracting the air. After the air has been extracted the globe is sealed, and the lamp is ready for use. Figure 7 shows the lamp complete:—

THE PERFECTED LAMP—FIGURE 7.

A is a glass globe, from which the air has been abstracted, resting on a stand, B. F is the little carbon filament connected by fine platinum wires, G G', to the wires, E E', leading to the screw posts, D D', and thence to the generating machine. The current, entering at D, passes up the wire E to the platinum clamp, G; thence through the carbon filament F to G', down the wire E' to the screw post D'; thence to the generating machine. It will be noticed, by reference to the complete lamp in figure 7, that it has no complex regulating apparatus, such as characterized the inventor's earlier labors. All the work he did in regulators was practically wasted, for he has lately realized that they were not at all necessary—no more so than a fifth wheel is to a coach.

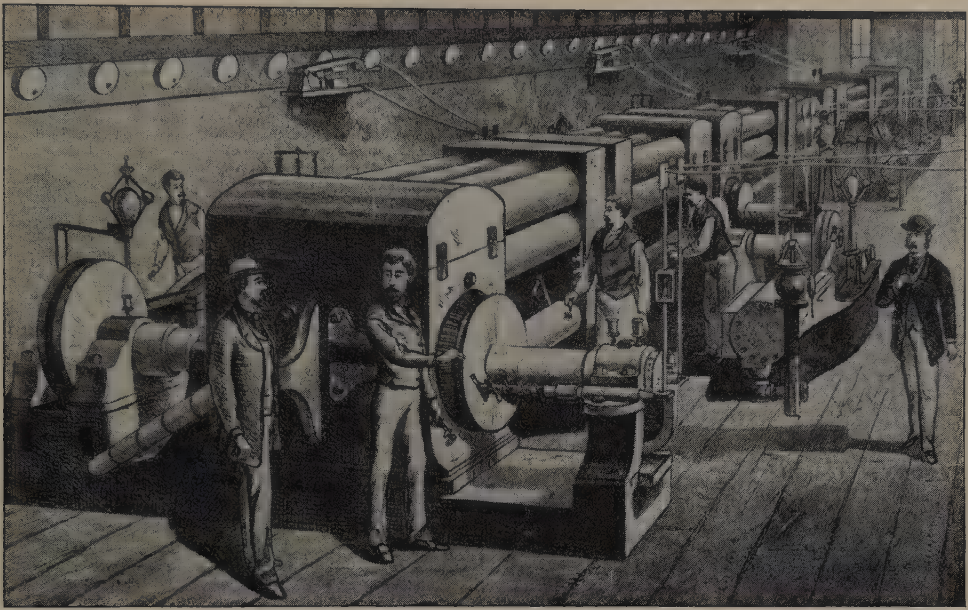
THE DOMESTIC MO...

361 From the *New York Herald*, Dec. 21, 1879

FIRST ANNOUNCEMENT OF EDISON'S ELECTRIC LIGHT

NOTWITHSTANDING the success of Edison's carbonized-thread filament lamp of October 21, 1879, it did not satisfy him because it burned out in forty-five hours. Searching for a better material, he found that a filament made of carbonized paper gave several hundred hours' service. Since this made the lamp a commercial possibility Edison planned a great demonstration to be held in December, 1879. For this purpose wires and lamps were installed in several homes in Menlo Park and some lamps were mounted on poles alongside the highway.

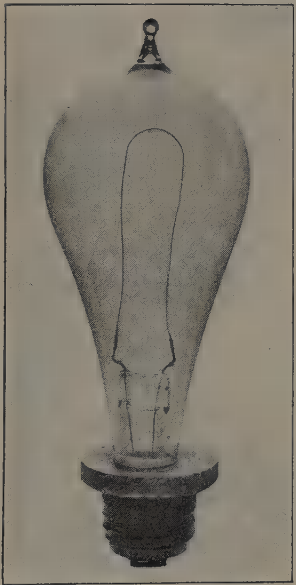
The *New York Herald* for Sunday, December 21, 1879, published an account of Edison's invention and the public demonstration. The result of this article was a rush by the public to Menlo Park so great that the Pennsylvania Railroad was forced to run special trains to accommodate the curiosity-seekers. The demonstration was a technical and a publicity success.



362 From the *Scientific American*, Aug. 26, 1882

THE FIRST EDISON ELECTRIC LIGHTING STATION, NEW YORK

Edison's first sale of his lighting system with incandescent lamps was made to the steamship *Columbia*, which started on May 2, 1880, on a voyage around South America to San Francisco. Two years later the Edison Company opened at Pearl Street, New York, its first electric lighting station. For a time this was one of the wonders of the metropolis, attracting the attention of scientists, writers, and inquisitive persons of all sorts.



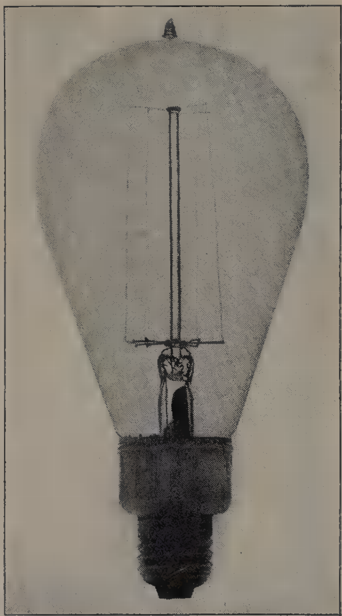
363 From an exhibit in the United States National Museum

FINAL FORM OF THE SCREW BASE, 1881

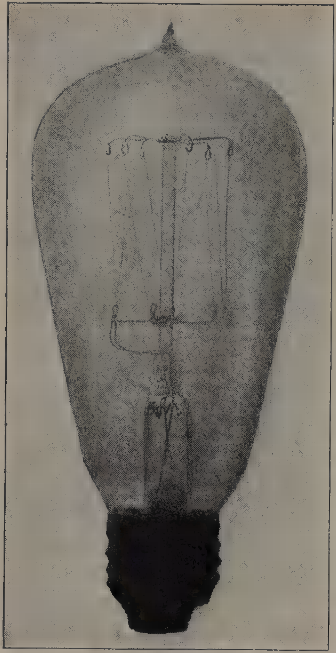
Since Edison's incandescent lamps burned out eventually and had to be replaced, the first form of lamp base proved inconvenient. After a number of attempts a form was evolved in 1881 that has remained the standard base.

TUNGSTEN LAMP, 1907

The later improvements of the incandescent lamps were concerned with finding a better filament than carbonized substances. The greatest advance in incandescent lamps was made when tungsten was chosen for the filament. We owe the tungsten lamp to two young Austrians, Alexander Just and Franz Hanaman. These laboratory assistants had two struggles, one with poverty, the other with the extreme hardness and brittleness of the metal with which they were working. Finding it then impossible to draw tungsten into wire, they produced a filament by ingenious manipulations of the metal, first as a powder and then as a paste, the latter being forced into a thread by pressing it through a hole drilled through a diamond. This thread was then treated in various ways until it could be used as a filament. Although the pressed tungsten filament was extremely fragile, it was also highly efficient and in reality caused a small revolution in the electrical world. By its use railroad cars were lighted by electricity instead of by gas or oil, arc lights were displaced, and all former types of incandescent lamps rendered obsolete.



364 Courtesy of the Edison Lamp Works



365 Courtesy of the Edison Lamp Works

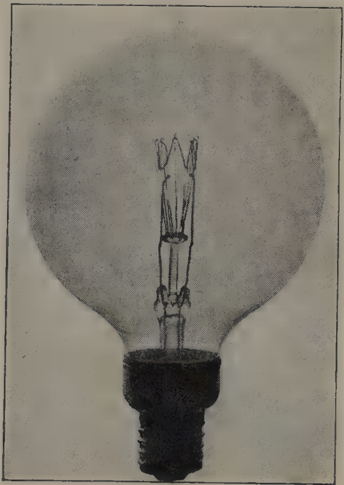
DRAWN TUNGSTEN WIRE LAMP, 1911

The manufacture of tungsten lamps was greatly simplified in 1911 when Dr. William D. Coolidge, after long and patient research, perfected a process by which the hard brittle metal could be rendered sufficiently ductile to be drawn into wire. The wire tungsten filaments were stronger and more efficient than the pressed tungsten filament. It led to the use of electric lights for automobiles, headlights for engines, better illumination for street cars, pocket flashlights, and in addition strengthened the position of incandescent lighting in all those fields first invaded by the pressed tungsten filament.

366 From a photograph, courtesy of the General Electric Company

WILLIAM D. COOLIDGE, 1873–

William David Coolidge is a representative of the modern idea of employing research men in business. Born in 1873, he graduated from the Massachusetts Institute of Technology and won a doctor's degree at Leipzig. From "Tech" the General Electric Company called him to a position in its Research Department. The work of Coolidge has assured for him a permanent place in the history of electrical achievement.

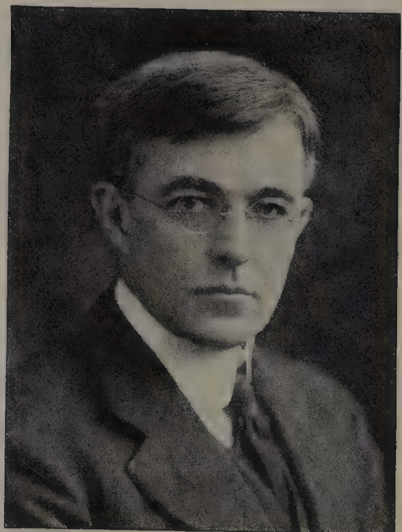


367 Courtesy of the Edison Lamp Works

GAS-FILLED TUNGSTEN LAMP, 1913

The gas-filled tungsten lamp invented by Dr. Irving Langmuir in 1913 completes to date (1926) the major improvements in incandescent lamps. By operating a coiled filament in an inert gas, Dr. Langmuir was able to gain a marked increase in light because the gas permitted the filament to function at a much higher temperature.

The various tungsten lamps, by their simplicity, cheapness, and efficiency, have doomed all other electric illuminants except the magnetite and mercury arc lamps used for special purposes. For general use the arc light is well-nigh extinct.



368 From a photograph, courtesy of the General Electric Company

IRVING LANGMUIR, 1881–, INVENTOR OF THE GAS-FILLED TUNGSTEN LAMP

In contrast with Edison and William Stanley who represent a former age of self-educated electricians, Irving Langmuir illustrates the new electrical scientist well trained in schools and laboratories. Langmuir was born in Brooklyn in 1881, graduated from Columbia School of Mines, and received a doctor's degree at Göttingen. His career began as an instructor in physics at Stevens Institute, where his researches attracted the attention of the General Electric Company. As a result he was invited to the research staff of that corporation. Aside from gas-filled lamps his greatest contribution has been a device for detecting submarines.

369 From a photograph taken in 1902, courtesy of the General Electric Company, Pittsfield, Mass.

WILLIAM STANLEY, 1858–1916

William Stanley's place in the electrical Hall of Fame is due to his invention of the "transformer," a device that opened the way for the transmission of electrical energy over long distances and made possible the use of electricity for light and power many miles from the source of the electricity. The amount of current that is delivered at any point is dependent first upon the electromotive force, or voltage, and secondly upon the resistance of the conductor (wire).

All the early dynamos and electric lighting systems were operated by direct current; that is, by a current having a low voltage. This limited the distance separating the dynamo, and the light or motor using the current produced by the dynamo. The current having a low voltage, and the wire a high resistance which is increased by the length of the wire, it is obvious that if the dynamo and the light or motor were far apart, the current delivered at the point of use would be much less than the current produced at the dynamo. Yet lights and motors must have a low voltage current. Here then was a dilemma; low voltage was required, yet low voltage meant short distance transmission. Alternating currents have a high voltage; some have been produced with a voltage as high as a million. High voltage currents, therefore, can be sent for hundreds of miles over a wire without serious difficulty or loss. Hence for economic transmission high voltage currents are necessary, but for use low voltage current is required. Stanley's great contribution was a device for changing high voltage currents to low without serious loss in the device itself and without complicated mechanism. Born in 1858 at Brooklyn, New York, he became associated in 1884 with George Westinghouse. In the following year he invented his transformer.

370 New York from Metropolitan Tower at Night, courtesy of the New York Edison Company

ELECTRIC LIGHT IN MODERN LIFE

Electric lighting, perfected by the tireless experiments of many men, is among the most striking features of modern life. To remote country villages, in which the distribution of gas would be impracticable, the wires bring electric current. Although operating countless useful devices in home, office, and factory, the great gift of electricity is light. A modern city ablaze in the night, its huge buildings fretted with golden fires, its towers leaping to the glowing clouds, and its brilliant avenues thronged with a restless humanity, presents a spectacle upon which the philosopher may well ponder, and by which the soul of the citizen and the poet cannot but be enkindled.

CHAPTER VIII

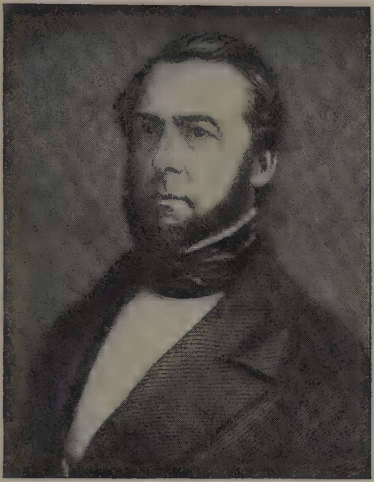
THE HUM OF THE SHUTTLE

AS textiles were among the first so have they remained among the most important of American factory-made products. When Eli Whitney invented the cotton gin near the end of the eighteenth century, he made possible the development in the United States of one of the world's most important cotton-producing areas. Cheap cotton cloth manufactured by the New England mills after the War of 1812 found a ready market not only on the farms and in the cities of the Atlantic seaboard, but among the people who were vigorously pushing into the Mississippi valley. The machines which had made possible the Industrial Revolution in England at the end of the eighteenth century were reproduced in American factories. During the growth in textile manufacture in the first half of the eighteenth century, they were improved and adapted to American conditions. In 1860 cotton was the chief textile manufactured in the United States.

The Civil War had no more important effect upon American industry than upon textiles. The supply of cotton from the South was practically shut off for four years. The Union armies demanded woolen uniforms. Cotton manufacturing was retarded and the making of woolens vastly stimulated. Not until 1900 did cotton regain its former preëminence. In the census of manufactures taken nineteen years later the value of cotton goods was found to be nearly forty per cent of the value of all the textiles combined. This forging ahead of cotton was not due to a diminution in the demand for wool. During the period the manufacture of woolen goods steadily and rapidly increased. But the demand for various types of cotton cloth also greatly increased. To manufacture this cloth cheaply and efficiently wonderful new machines have appeared in the cotton factories. So rapid has been the mechanical development that large concerns have been compelled to change their machinery two and even three times in the period since 1860. Here the automatic machine that seems to work almost with intelligence has replaced a host of laborers.

The history of cotton manufacturing since the Civil War is typical of two other tendencies that marked American industrial advance. Between 1860 and 1919 in the New England states, the first home of cotton manufacturing in the United States, the number of cotton mills actually decreased while the number of spindles they contained was multiplying manyfold. This was the result of consolidation. But during the same period both the number of cotton mills and of spindles in the South vastly increased. The cotton factory seeks closer proximity to the supply of raw product. The shift marks an attempt on the part of the industry to adjust itself more perfectly to its American environment.

The spectacular development of American cotton manufacturing has been duplicated in wool and silk, in spite of the fact that America is dependent upon importation from a long distance for all its supply of raw material of the latter product and for much of the former. The development moreover has occurred in the face of the competition of many old and well established mills abroad. This is but one illustration of the industrial efficiency that has marked the development of the United States since the Civil War.



371 Charles Tillinghast James, 1804–62, from *DeBow's Review*, New Orleans, Dec., 1850

372 The James Steam Cotton Mill at Newburyport, Mass., from a photograph taken *ca.* 1890, now in the Newburyport Public Library

THE RISE OF THE STEAM COTTON MILL

It was the textile industry both in England and America that ushered in the modern factory system. The early history of industrialism is therefore the history of textile manufactures. The great textile centers, Waltham, Lowell, Saco, Holyoke, and Norwich, had developed by reason of their fortunate proximity to water power, and it was not until about 1850 that coal-fired steam engines threatened the supremacy of water-turned wheels. It was not comparative costs — for water power was cheaper than steam — but ease of expansion and freedom in location that caused textile men to use steam, first to carry the overload of water-driven factories, and later to assume almost the entire burden of driving the machinery. The first advocate of the steam engine for textile manufacture was General Charles T. James. He claimed that the best location for a cotton mill was at a seaport to which coal could be brought cheaply in barges. Although users of inland water power scoffed at James, he put his theory into practice at Salem and Newburyport, Massachusetts, and Portsmouth, New Hampshire.

373 Cotton Mills at Fall River. © Brown Brothers

FALL RIVER AS A COTTON MANUFACTURING CENTER

Fall River, Massachusetts, has completely demonstrated the correctness of James' theory. Situated upon an arm of Narragansett Bay, the city's coal is deposited almost at the mill doors. After the middle of the century Fall River's steam-driven mills rapidly overtook the production of the inland water-power factories, and eventually the city overtopped its long established rival Lowell. For decades thereafter Fall River was the leading cotton manufacturing city in America.

374 The Wamsutta Mills, 1847, courtesy of the Wamsutta Company, New Bedford, Mass.

COTTON MILLS AT NEW BEDFORD

But Fall River has met a competitor near at hand. New Bedford, upon the decline of whaling, turned its capital and surplus labor into cotton manufacture. With the same advantages as Fall River, it at once challenged its supremacy and between 1910 and 1915 forged ahead of its neighbor. Since then New Bedford has continued to make more cotton yarn and goods than any city in the United States, and lays claim as well to superiority in quality of output. The first cotton mill in New Bedford was erected in 1847 by the Wamsutta Company, while the whaling industry was still at its height. These mills have continued in uninterrupted operation to the present day.

MOISTENING THE AIR OF A COTTON MILL

In addition to facility in securing coal both Fall River and New Bedford share another advantage due to their coastwise position — dampness of climate. The rubbing that yarn gets in manufacture creates frictional electricity which causes tangles, roughened surfaces and many other manufacturing difficulties. Dry air enhances the troubles but a moist atmosphere relieves them, because moisture is a good conductor of electricity. The condition of the air may vary the costs of textile manufacture by hundreds of dollars a day. A naturally moist atmosphere such as that near the sea is therefore of the utmost benefit to a textile mill. Whenever nature is deficient, manufacturers must create the proper conditions by artificial means. The device that sprays water or steam into the workroom (seen in the upper part of the illustration) is called a humidifier.

375 Humidifiers in a Cotton Mill, courtesy of the American Moistening Company, Providence, R. I.

376 From *Harper's Weekly*, July 25, 1868, after a drawing by Winslow Homer

COMING HOME FROM THE FACTORY, 1868

One of the most interesting sights to our forefathers was the home-bound crowd of factory operatives at "bell time," as the evening hour of the finished workday was then called. It was a sight like this that gave Charles Dickens his only favorable impression of America, if we are to judge by his *American Notes*, 1842. It is interesting to observe in this drawing made at Lawrence, Massachusetts, the number of Irish types. This fact foreshadows a change in mill labor, the substitution of immigrants for native American "help."

377

378

IRISH TEXTILE WORKERS

379 French-Canadian Woman in a New England Factory. © Keystone View Company

380 PORTUGUESE

TEXTILE WORKERS, 1925

In time new opportunities called American girls from the mills. Their places were filled by immigrants; first by the Irish, then by French-Canadians, and eventually by Portuguese, Italians, Greeks and Slavs. With the arrival of immigrant labor our textile mills had no cause for boasting about their labor policies or practices. The excellent beginning was not maintained. Individual mills have done much to improve labor conditions and to keep labor standards up to American levels, but there are many plants and whole communities where labor conditions are deplorable.

381 ITALIANS

382 GREEKS

383 POLES

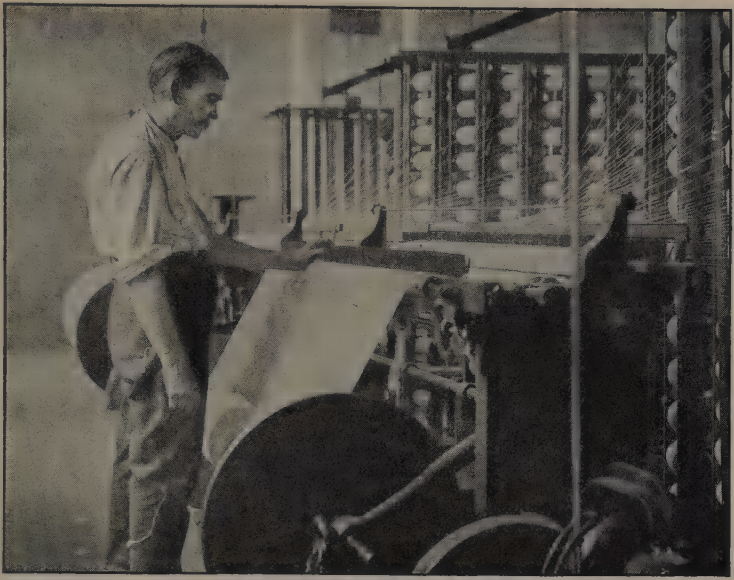
Photographs of Textile Workers, courtesy of the American Woolen Company, Boston

384 Cotton Mills, West Point, Georgia, from a photograph by the United States Department of Agriculture

THE SOUTH CHALLENGES NEW ENGLAND'S SUPREMACY

In the years following 1814, when the first complete cotton factory was set up at Waltham, Massachusetts, the leadership of New England was uncontested until about 1870. Then the Piedmont sections of the Carolinas and Georgia began their startling career. The South offered proximity to raw materials, abundant low-priced labor, freedom from onerous legal restrictions, cheap hydroelectric power, the latest equipment, low taxes and a large home market. To offset these advantages the North possessed experience, abundant capital, favorable climate, conveniently located dye houses and bleacheries, easy access to the New York and Boston markets, and mills whose original cost had largely been written off the books. At first the competition between the two regions created a division in the type of goods made, the inexperienced South specializing in the cheaper grades whose values depended mostly on the raw material they contained, whereas the North turned to products whose value was more largely determined by skilled workmanship. But time has reduced this expedient of the North; and the South, which already uses more raw cotton and is expanding its equipment more rapidly, will in the immediate future enter upon a struggle with the North for complete supremacy.

385 Cotton Mills, Albemarle, North Carolina, from a photograph by the United States Department of Agriculture



386 From a photograph by Lewis W. Hine

A MOUNTAINEER IN A SOUTHERN COTTON MILL

THE expansion of cotton manufacture in the South has again called into the mills a native white labor group. Mountaineers, with an ancestry traceable to the original colonial settlers, have furnished the southern mills with the larger part of their operatives. In addition, these factories have drawn white farmers and their families from the small farms of the Carolinas and Georgia. The mountaineers coming into the textile towns make their homes there, but the farmer fluctuates between mill and farm in accordance with the price of cotton; if cotton is low, then to the mill he goes; if cotton is high, the mill is temporarily forsaken. Both the mountaineers and the farmers change frequently from one mill village to another, often merely for the sake of variety.

387 From a photograph by the United States Department of Agriculture

PICKING ROOM OF A COTTON MILL

SOME southern cotton mills are so fortunately situated that they can get loose unbaled cotton direct from the gin, but nearly all factories receive their raw cotton in bales. The first step in manufacture, therefore, is opening the bales, loosening the lint, cleaning it and picking apart the matted fibers. This is done by a series of machines. The first "picker" in the series does its work only roughly, but each successive "picker" is adjusted to accomplish a more thorough task. The significance of this process may be realized from the fact that the five hundred pounds of cotton in a compressed bale take up nearly twice as much space after the bale has been "picked," and that the "picking" must be so fine that the fibers can later be arranged in smooth, clean, even, strong yarn. The yarn from one bale is seldom less than five hundred miles long, is usually five thousand miles and often fifty thousand. The efficiency of the "picker room" has a bearing upon the amount of yarn that can be spun from one bale.

388 © Keystone View Company

CARDING

THE cotton as it leaves the pickers is called a "lap" and consists of fibers criss-crossed in every conceivable manner. Mixed with the fibers are small adhering pieces of leaf, seed, stalk, and minute sections of the boll. The next process is designed to straighten the fibers so that they lie parallel, and to rid them of foreign matter, while at the same time the weight per yard of the lap is reduced by attenuation. The machine which does this work is called a "card" and the process "carding." The action of the machine is akin to brushing or combing and is accomplished by bringing the lap against sets of wire teeth differently arranged in various types of carding machines. As the web of parallelized fibers leaves the "card" it is collected into a narrower ribbon called a "sliver" and coiled in a tall cylindrical can (at left of illustration). It is then ready to be carried to the next operation.

DRAWING FRAMES

FROM the card the cans of sliver are generally taken to a "drawing frame." This machine is so arranged that the sliver passes between two sets of rolls one above the other. The rolls may be made of different materials, or one set covered with various substances or materials while the other remains bare. The sets, too, revolve at different speeds. The objects of the drawing frame are to complete the parallelizing of the fibers, attenuate them, and produce a more even sliver. The rolls pull the fibers past one another and so lay them parallel. Even slivers are obtained in the drawing frame by combining two or more of the slivers taken from the cards. The cotton is made to pass through at least two and sometimes as many as four drawing frames in order to get yarn of the required degree of fineness. While it has been customary to coil the slivers in great cans that stand before the drawing frames, in many factories this is not the rule. The moving of cans from one frame to the next consumes time and labor. In order to save this expense the drawing frames may be so grouped that the product of one series becomes the raw material of the next, the slivers passing directly from one machine to another without being run into cans.

389 From a photograph by the United States Department of Agriculture

THE COTTON COMBER

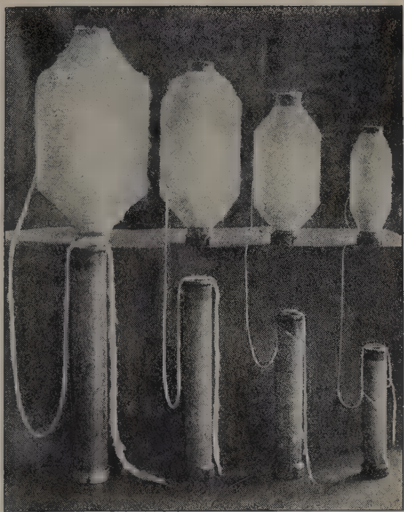
390 © Ewing Galloway

For very fine yarns a process called "combing" comes between carding and drawing, the object of which is to remove short fibers from the sliver. The lap first passes through two machines where several laps are combined, the resultant sliver passing into a "comb." This is a highly complicated mechanism that grips a segment of the sliver and shoves it against cylinders set thickly with fine needles which, passing through the fringe of cotton, remove all the small fibers and minute knots, the long fibers being held firmly in the grip device. The long fibers are pieced together within the machine, stretched out, and finally delivered in a coiled sliver into a can.

FLY FRAMES

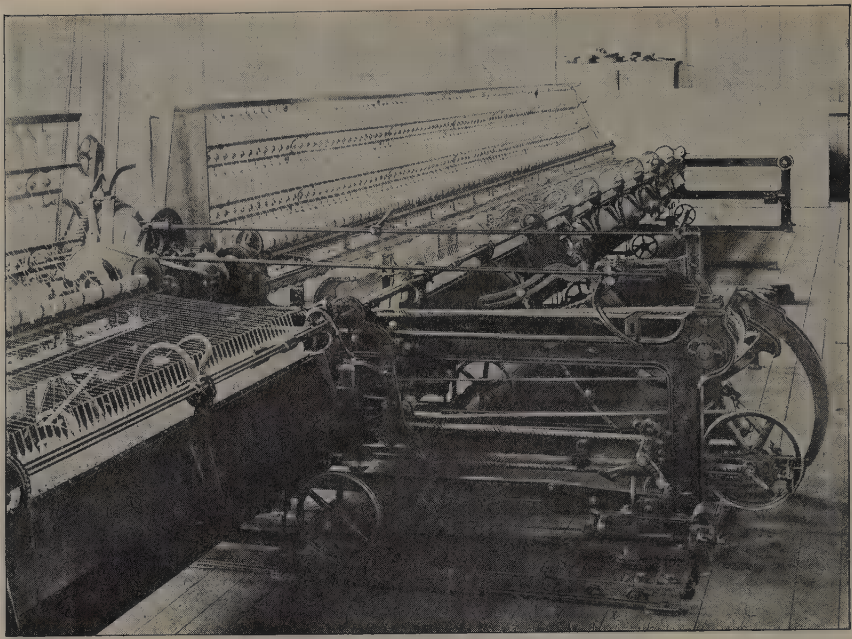
Although the drawing frames or comber have improved the sliver it is still too bulky to be spun. It next passes through a series of machines where the slivers are doubled and redoubled to produce the greatest evenness, and attenuated to an unbelievable extent. For example, a yard of finished "roving" may weigh only one fiftieth to one hundred fiftieth as much as a yard of sliver at the beginning of the process. The machines that perfect this attenuation and evening are called "fly frames" and speeders. Since the continual attenuation weakens the sliver the frames are arranged to twist it in order that it may hold together. After twisting the sliver is wound upon a bobbin. The attenuation is produced by holding the sliver in one part of the machine at one speed and pulling it toward another part operating at a higher speed. The finished roving — the name given the yarn after it has passed the fly frame — is ready for spinning.

391 © Keystone View Company



392 Different Stages of Roving. © Keystone View Company

MULE SPINNING



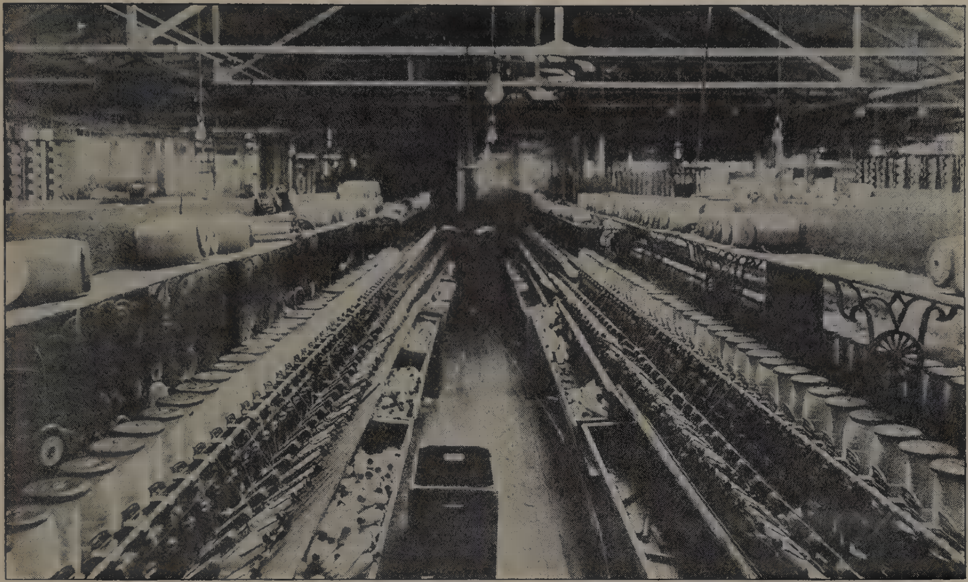
393 Courtesy of the Mason Machine Works, Taunton, Mass.

THE oldest spinning machine is known as the "mule." This machine is very long and has two parts, one fixed, the other movable in a forward and back motion. The yarn is placed on the fixed portion and attached to the movable section. When the section runs forward the yarn is stretched. Upon the return the yarn is twisted or spun and wound about a bobbin. Simple as this sounds, the machine requires great skill to operate and the work is heavy. Consequently nearly all mule spinners are men. Most mills use the mule spinner only for the finest yarns. The device, which was one of the three or four inventions marking the beginning of the Industrial Revolution, has been replaced for ordinary work by more nearly automatic machines.

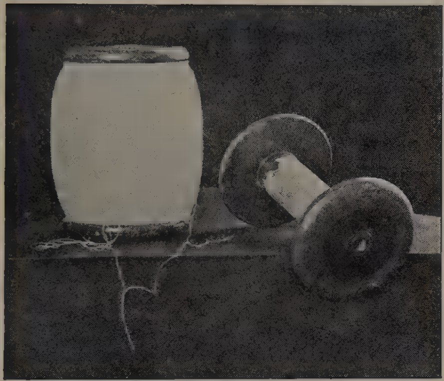
SPINNING ROOM IN A COTTON MILL

THE common and more modern spinning machine is called the "ring spinner." In this the yarn is stretched by passing between two rolls operating at different speeds as in the drawing frame. The twist is given by a flying ring through which the yarn passes. These machines are nearly automatic and may therefore be attended by girls whose sole tasks consist in keeping the mechanism supplied with yarn, and joining broken ends of yarn. Although the ring spinner does not produce as fine yarn as the mule, it is so much quicker and cheaper in operation that it is employed for most of the yarn produced.

394 © Keystone View Company



395 From a photograph by the United States Department of Agriculture



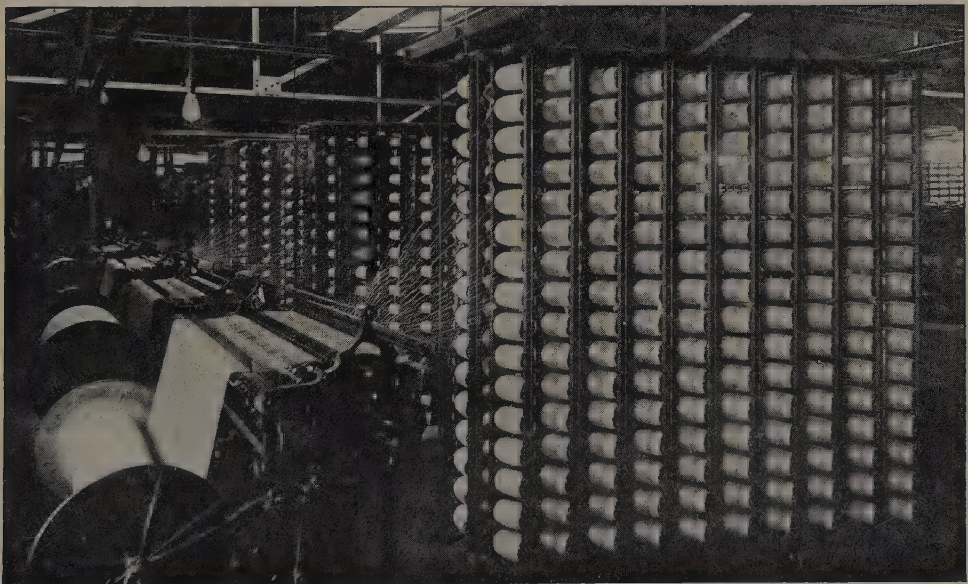
396 Full and Empty Warp Spools. © Keystone View Company

WINDING AND SPOOLING ROOM

THE spun yarn is wound and spooled in preparation for the preliminary operations of weaving. What a contrast is such a room to the spinning wheel which a little more than a century ago was a household commonplace.

BEAMING

THE first step in preparation for weaving is called "beaming." The beam is a huge roll upon which is wound from separate spools each thread that is to form part of the warp of the cloth. Beaming must be done with care to see that each thread is wound smoothly on the roll in order that there may be no hindrance to weaving.



397 From a photograph by the United States Department of Agriculture

398 From a photograph by the United States Department of Agriculture

"DRAWING IN"

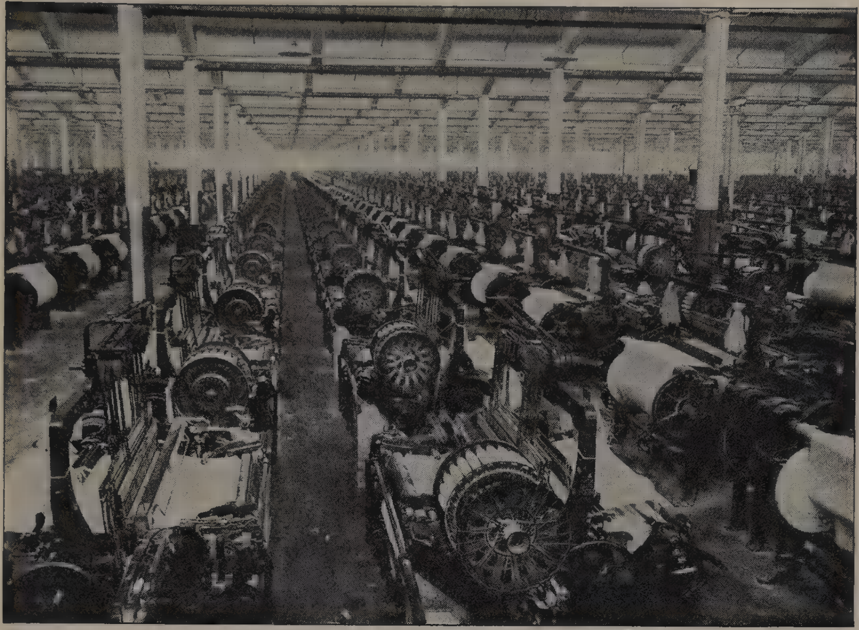
The beam roll is carried to the "drawing in" room of the mill. Each thread on the beam must be passed through an eye in a wire. The wires are held together in a frame which will become part of the mechanism of the loom or weaving machine. There is no machine in general use for pulling the beam threads through the wire eyes and this work is done by hand. Since it is similar to threading a needle, albeit a gigantic one, the work is most often done by women, another instance in industry where women make more desirable workers than men.

A WEAVING ROOM, WITH LOOMS IN ACTION

Weaving consists in tightly interlocking two sets of threads at right angles to form a fabric. If one stands directly in front of a weaving machine — called a loom — the threads that run into the machine comprise the warp. Those that cross the warp at right angles from the side of the machine are named the weft (or woof). The weft thread from a bobbin is fed out of a container called a shuttle which drops the thread as the shuttle passes back and forth across the loom. Since the warp threads must bear nearly all the strain of the operation they necessarily are firmer and stronger than the weft or filling threads.

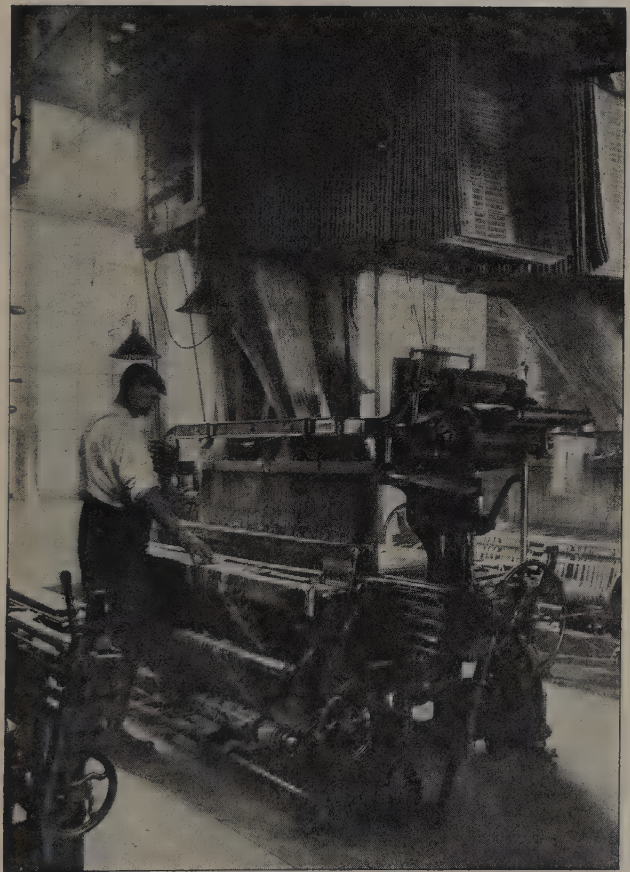
399 From a photograph by the United States Department of Agriculture

A WEAVE ROOM EQUIPPED WITH NORTHROP LOOMS



400 Courtesy of the Draper Corporation, Hopedale, Mass.

Of recent technical advances in the cotton industry the most important is the automatic loom. This machine, called the "Northrop" as well as the "Draper" loom, was invented in 1891 by James Northrop, English by birth but an American by adoption. The patents were purchased by the Draper Company of Hopedale, Mass. This company spent large amounts of money in perfecting the machine and adapting it to the varying exigencies of the textile industry. Although Northrop conceived the principle of the machine, the product, as it was put on the market in 1894 by the Draper Company, represented the efforts of at least five inventors who gave this task their entire time for three years. The automatic loom supplies itself with weft yarn from a filling hopper on the side, threads its own shuttle and stops itself when the shuttle is out of position or when a warp yarn breaks. The automatic loom saves two hundred loom stoppages per day, saves wear and tear on the loom by its accuracy of motion and continuous operation and reduces the amount of skill required by an operator. The labor cost of weaving was previously one half the cost of the manufacture of cotton cloth; the automatic loom cuts weaving costs in half. Once three persons were required to run one loom, nowadays with automatic looms one weaver may tend as many as thirty machines.



401 © Keystone View Company

A JACQUARD LOOM IN OPERATION

A still more complicated loom is the Jacquard, named for its French inventor. This loom automatically weaves fancy patterns in different colors. Its operation is too technical to describe, but the result is accomplished by means of the perforated cards which hang in a cluster above the machine. Nowhere better than in the modern textile factory can be seen the triumphs of man's inventive skill. The automatic machine has been made to produce almost unbelievable results. It is tireless, its work is always the same. So long as it is well made and properly cared for, it is dependable. It performs the labor of hundreds of skilled hands.

American manufactured Woolens.

For S A L E,

At the Hartford Woolen Manufactory.

A GREAT Variety of CLOTHS, SERGES, COATINGS, &c. ſuited to the preſent and approaching Seaſon.—The colours may be relied on, being *principally dyed in Grain*.—They have lately eſtabliſhed a *Blue Dye*, wherein all the different Shades from a *Pearl Colour* to *Navy Blue* are dyed—being the firſt Attempt of the kind in America. The Goods will be ſold on the moſt reaſonable Terms for ready Pay, and Credit will be given to thoſe who deal for a large Amount, where the Security is unqueſtionable.

As the owners of this Manufacture have been at great Expence in eſtabliſhing ſo uſeful a Branch of Buſineſs, it is to be preſumed the Shopkeepers in this State will exert themſelves in furthering ſo laudable an Undertaking by giving their Cloths a preference.

DANIEL HINSDALE, Agent.

Hartford, September 1789.

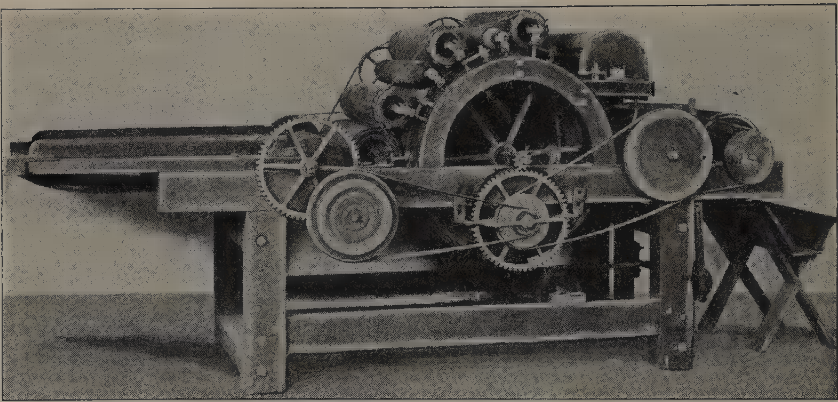
402 From the *Hartford Courant*, Sept. 14, 1789

THE FIRST WOOL FACTORY IN AMERICA

Cotton manufacture was born with the age of machinery, but the manipulation of wool for man's comfort is older than recorded history. By ageless custom, wool manufacture remained a household industry long after the manufacture of cotton in factories by machines was a demonstrated success.

It is said that the first American wool mill was established at Hartford, Connecticut, in 1788, by the Hartford Woolen Manufactory, a joint stock association sponsored by Jeremiah Wadsworth. This "mill," however, was mainly a collection under one roof of several hand-operated wool spinning and weaving devices, although water power also was actually employed.

This Hartford "mill" attained considerable fame. Washington upon his inauguration as President in 1789 was clothed in cloth made at Hartford. Despite the prestige, nowadays called advertising, created by this event, the Hartford venture had hard business conditions to meet. Household and imported cloth competed with its product; high operating costs and accumulations of unsold goods destroyed both profits and invested capital. It was kept alive by a lottery sanctioned by the state, but even this aid failed eventually and the stock and equipment of the enterprise were sold at auction.



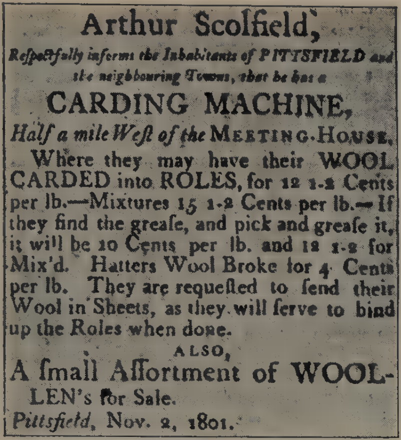
403 The Scholfield Carding Machine, from a photograph supplied by the Davis and Furber Machine Company, Andover, Mass.

THE SCHOLFIELDS, PIONEERS OF AMERICAN WOOL MANUFACTURE

The significance of the name of Slater in cotton manufacture is equaled in the wool branch of the textile industry by the names of John and Arthur Scholfield [Scolfield]. These two brothers came to America in 1793 from Yorkshire, the heart of the British wool industry, and established themselves in the shadow of Bunker Hill at Charlestown. They eventually came in contact with local capitalists and promoters — among whom was Moses Brown, who had backed Slater — and gained the financial assistance necessary to inaugurate a wool manufactory at Newburyport, Massachusetts, in 1794. The most essential contribution of the Scholfields to this enterprise was the erection of the first wool carding machine in this country. This machine was placed in the Blyfield mill at Newburyport, Massachusetts. The machine pictured is said to be the original, still in existence.

There is some question as to whether the Scholfields actually constructed the machine or procured it from England. In view of the rigidity of the English law and practice concerning the exportation of machinery, parts or even drawings, it seems improbable that this carding machine was imported and more likely that the Scholfields, like Slater, made it from memory of what they had seen and used in British mills. The Scholfields also constructed some of the earliest American wool spinning jennies and actually produced the first piece of American machine-made broadcloth.

The Newburyport mill continued in operation for a half century and was the first successful wool mill in America, the earlier Hartford venture having failed.


Arthur Scolfield,
Respectfully informs the Inhabitants of PITTSFIELD and the neighbouring Towns, that he has a
CARDING MACHINE,
Half a mile West of the MEETING-HOUSE,
Where they may have their WOOL CARDED into ROLES, for 12 1-2 Cents per lb.—Mixtures 15 1-2 Cents per lb.—If they find the greafe, and pick and greafe it, it will be 10 Cents per lb. and 12 1-2 for Mix'd. Hatters Wool Broke for 4 Cents per lb. They are requefted to fend their Wool in Sheets, as they will ferve to bind up the Roles when done.
ALSO,
A fmall Affortment of WOOLLEN's for Sale.
Pittsfield, Nov. 2, 1801.

404 From *The Pittsfield Sun*, Nov. 2, 1801

THE SCHOLFIELDS AT PITTSFIELD, 1801

The Scholfields, however, were too enterprising to remain at the Newburyport mill, and their knowledge of wool manufacture was in great demand. Half a dozen pioneer wool mills were more or less associated with one or the other of the brothers.

The Berkshire Hills region of western Connecticut and Massachusetts by 1800 had become an important sheep country. A few years later it became world famous for its merino sheep. Arthur Scholfield was attracted to this territory and in 1801 he started a wool mill at Pittsfield, Massachusetts. This mill had a checkered career and Arthur Scholfield soon turned from it to other ventures.


405 From Frank Landon Humphreys, *Life and Times of David Humphreys*, 1917, courtesy of the author and of G. P. Putnam's Sons

THE HUMPHREYS MILL, 1806

Another name of equal importance in the early history of American wool manufacturing is that of General David Humphreys. In 1802, while American minister to Spain, Humphreys secured some specimens of merino sheep which he sent to his home town, Derby, Connecticut. From there they spread to the Berkshires, an ideal sheep country. Merinos were also independently introduced into the Hudson valley and Vermont. By 1812 the breeding of merino sheep was carried on so widely and successfully that American merinos were everywhere in demand. Humphreys on his return home turned to the manufacture of the merino wool. At a large waterfall in the Naugatuck River near Derby, he built a factory and founded a village called for a time Humphreysville.


406 From a woodcut made in 1848, in the *Bulletin of the National Association of Wool Manufacturers*, Dec., 1902

MIDDLESEX MILLS, LOWELL, 1830

Wool manufacture, unlike the cotton, remained a small-scale industry carried on wherever there were communities with small water-power sites. The many vicissitudes of fashion, tariff, scarcity and variability of raw materials, household and foreign competition, tended to restrict the scale of operations, dependent, as the industry was, largely upon skilled male labor.

When, therefore, in 1830, the Middlesex Company, of which Samuel Lawrence and William W. Stone were the foremost stockholders, started to build a great wool mill at Lowell on the site where the original canal entered the Concord River, the project was greeted with doleful predictions of failure.

In 1848 the Middlesex Company had a capital of one million dollars, then an unheard-of sum, invested in wool manufacture, although usual enough in the other textile, cotton. Although the Middlesex mill was not the first complete wool mill in America — as is sometimes stated — it was the largest of its kind in that day, and was the first to be organized on the plan of the modern corporation. The original company failed in the panic of 1857 but the business was reorganized and continued. Samuel Lawrence, belonging to the family of the Groton Lawrences, whose name is closely identified with Boston commerce and New England textile manufacture, was the chief stockholder in the Middlesex Company, and is said to have conceived the idea, although not the mechanical appliances, which converted the Crompton cotton loom to the weaving of fancy woolens. These were first produced in America in the Middlesex mills.

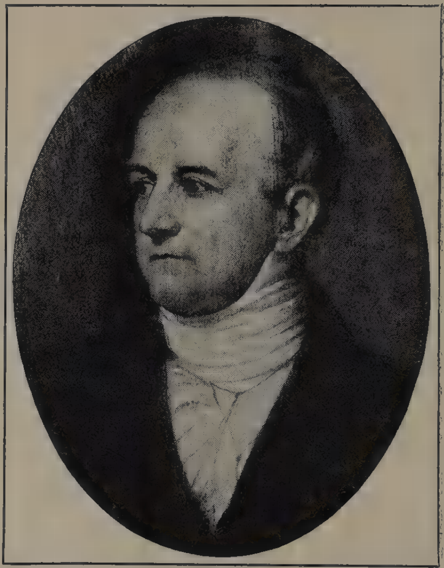
407 From the portrait by Chester Harding (1792–1866) in possession of Bishop William Lawrence, Boston

AMOS LAWRENCE, 1786–1852

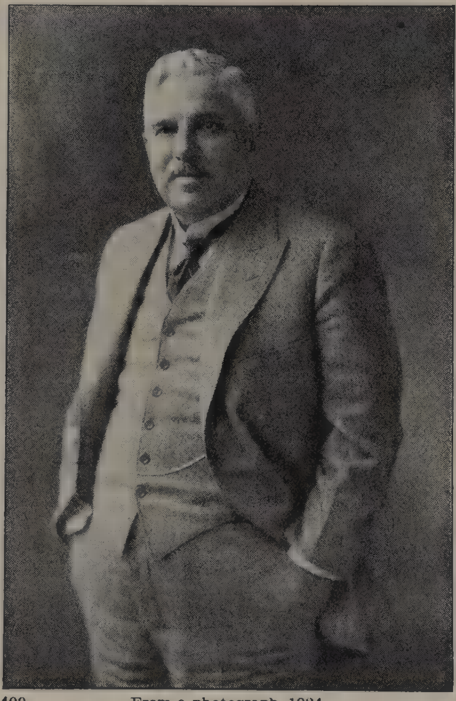
Amos Lawrence, himself distinguished, came from a family long accustomed to distinction. The founder of the American branch, John Lawrence, was a member of Governor Winthrop's company, and was one of the original landholders in Groton, Massachusetts, where Amos was born. Amos Lawrence, after attending Groton Academy, became a clerk in a country store but soon went to Boston to enter upon commercial pursuits. In 1807 he opened his own business house and amassed a fortune. The capital gained from commerce Amos Lawrence turned in part into the textile industry of New England, and he was a prominent member of the small group of Boston capitalists who established New England's fame as a manufacturing center. After retiring from active business in 1831 Amos Lawrence became the Andrew Carnegie of his time. He did not found libraries, but he bought good books literally by the barrel and distributed them from his carriage to those who he thought would profit by their use. He was also a benefactor of colleges and schools.

ABBOTT LAWRENCE, 1792–1855

Abbott Lawrence served his apprenticeship in commerce in his older brother's Boston establishment. Upon coming of age in 1814 he was taken into partnership with Amos. They were chiefly concerned with the sale on commission of imported cottons and woolens. As a result of their work in developing the American manufacture of textiles, the city of Lawrence was named for them. They had investments, however, in many mills other than those in Lawrence itself. Abbott Lawrence was not only a merchant and a manufacturer but also a politician. He served in Congress and lacked but six votes of being nominated for vice-president on the Taylor ticket. He declined a cabinet portfolio under Taylor but accepted the appointment of American minister to Great Britain, where he made an excellent reputation for himself and his country. Like his brother Amos, he was also a philanthropist with an especial interest in education. The Lawrence Scientific School of Harvard University was endowed by Abbott Lawrence.



408 From the portrait by George P. A. Healy (1808–94) in possession of Mrs. Henry Parkman, Jr., Boston

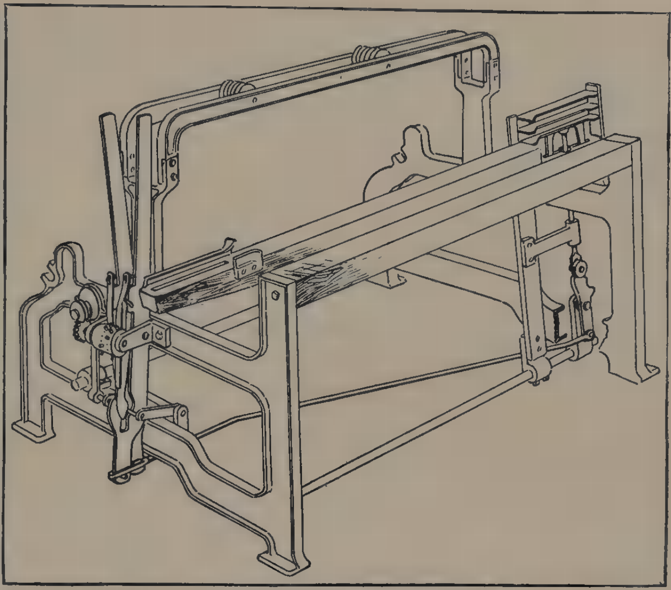


409 From a photograph, 1924

WILLIAM MADISON WOOD, 1861–1926

William M. Wood was the industrial heir in the woolen industry of the Lawrences and others of the previous generation. He was born at Martha's Vineyard and after a public school education entered the Wamsutta Mills of New Bedford as a clerk. He assisted in the reorganization of several textile enterprises in Fall River. This drew him back into manufacturing, and he became paymaster and general agent for a woolen mill in Lawrence. When the twenty-eight woolen manufacturing companies that comprise the American Woolen Company were merged, Wood entered the combine and eventually became its president, a position he held with honor for many years.

410 Lucius James Knowles, 1819–84, courtesy of the Crompton & Knowles Loom Works, Worcester, Mass.



411 Sketch of the Knowles Loom, patented 1856, courtesy of the Crompton & Knowles Loom Works

KNOWLES AND HIS LOOM

Lucius James Knowles was one of the men who gave rise to the idea that Yankees had a peculiar inventive genius. Born in Harwich, Massachusetts, and well educated, Knowles started his career as a clerk in a country store at Shrewsbury, but even as a clerk his mechanical ingenuity led him to invent a safety steam boiler regulator. Forsaking the store, Knowles went to Worcester where for two years he was a photographer, at the same time carrying on an electric gilding and silver polishing business. During this period he invented a machine for winding thread on spools, previously a slow, laborious hand job.

412 Courtesy of the Crompton & Knowles Loom Works

Knowles' next business venture was as a manufacturer of satinets. This turned his interest to looms, and he took out several patents on improvements upon the plain loom. His fame, however, rests upon his invention and perfection of a loom for weaving fancy patterned woolen goods.

These looms were manufactured by himself and his brother F. B. Knowles under the firm name of L. J. Knowles & Brother. Their first product was a loom on which could be woven the materials for hoop skirts. Soon they were among the leading manufacturers of fancy looms in America and throughout the world. Knowles was also the inventor of a steam pump.

WILLIAM CROMPTON, 1806–91

Although Lowell had introduced the power loom into the cotton industry in 1814, it was not until 1828 that a power loom was successfully applied to weaving broad goods in the woolen industry, and it was not until 1840 that such a loom was designed for fancy woolen goods. The credit for this latter achievement goes to William Crompton.

Crompton was a Lancashire Englishman who settled in Taunton, Massachusetts, in 1836 and obtained employment in a cotton mill. There he made certain improvements in a loom that permitted the power weaving of fancy cottons. This came to the attention of Samuel Lawrence of the Middlesex Mills and he engaged Crompton to perfect a power loom for weaving fancy figured woolens. After much effort and many disappointments, Crompton at last succeeded. His loom revolutionized the weaving of this style of woolen goods throughout the world.

413 George Crompton, 1829–86, courtesy of the Crompton & Knowles Loom Works

414 The Crompton Loom Works in 1870, from a photograph by courtesy of the Crompton & Knowles Loom Works

THE CROMPTON LOOM

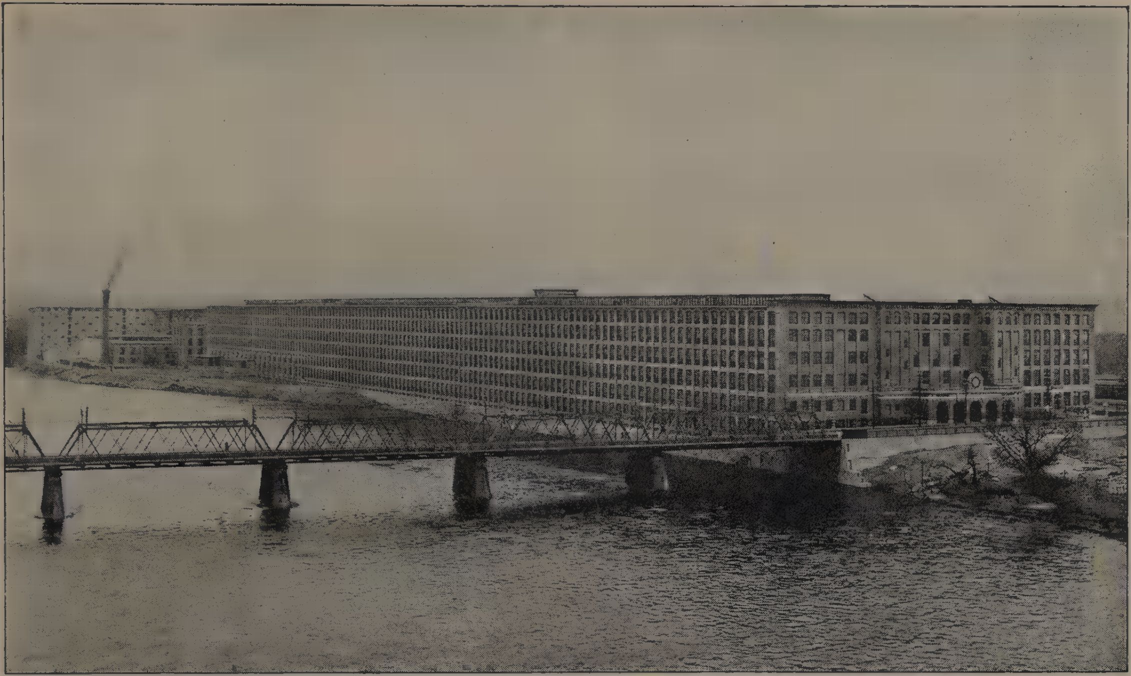
William Crompton himself never realized much from his invention, but his son George Crompton took the father's patent, invented a host of improvements for the loom and at Worcester manufactured the machines on a large scale. The Crompton Works in time shared with the Knowles Loom Company most of the output of looms in America and led the world in this class of machinery. Eventually, in 1897, the two firms were combined as the Crompton and Knowles Loom Works. This firm has ever since been a dominant figure in the textile machine business.

415 © The American Woolen Company, Lawrence, Mass.

SORTING FINE AUSTRALIAN WOOL

Since wool is an animal product, its quality is affected by everything that happens to a sheep during the year the fleece is grown. The breed of sheep, climate, soil, color of soil, intermittency of hot and cold weather, rainy or dry seasons, parasites, the kind and amount of weeds in the feeding places, all materially influence the quality of wool. The raw material is consequently never uniform, the fleeces of even two sheep never being exactly alike. In order to bring the product as close to standard as possible, the first operation is the sorting and classification of wool. The wholesale dealers, of course, do considerable sorting before the wool is sold to manufacturers, but the latter must refine the wholesalers' classification.

This sorting, together with scouring — for raw wool is greasy and exceedingly dirty — are preliminary manufacturing operations not found in the cotton industry. Otherwise, the actual manufacture of wool, although by no means identical with cotton, is so similar that it is not necessary to repeat the story.



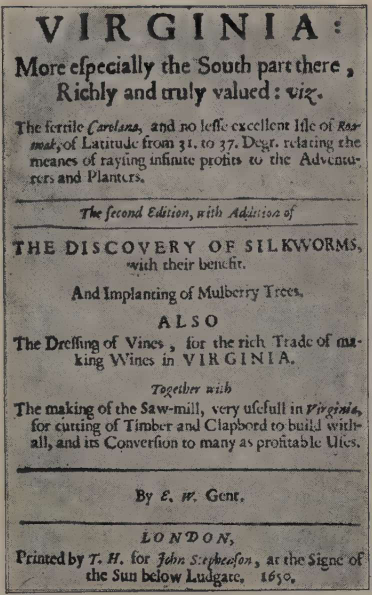
416 The Wood Worsted Mill, Lawrence, Mass., courtesy of the American Woolen Company. © A. B. Smith

LARGE- AND SMALL-SCALE WOOLEN MILLS

Wool manufacturing is carried on in two ways, one large-scale and localized, the other small-scale and decentralized. Worsted mills are large and centrally located near Boston, the second largest wool market in the world. Worsted cloth, manufactured from the long woolen fibers, may be made by machinery with a large proportion of unskilled or semiskilled labor. These factors make worsted manufacture economically similar to cotton, and the two textiles have had a similar history.

Woolen goods, on the other hand, made from fine short-fibered wool, depend on skilled male labor and upon the vagaries of fashion. Such mills are small, and are scattered over the whole country. Many of them are constructed of stone or brick, although wooden structures are often seen. In a great many cases the woolen mill is the only factory enterprise in the village.

417 Typical Small-Scale Woolen Mill, Elmville, Conn., courtesy of the American Woolen Company


VIRGINIA:
More especially the South part there, Richly and truly valued: *viz.*

The fertile *Carolana*, and no lesse excellent Isle of *Roanoak*, of Latitude from 31. to 37. Degr. relating the meanes of raysing infinite profits to the Adventurers and Planters.

The second Edition, with Addition of

THE DISCOVERY OF SILKWORMS, with their benefit.

And Implanting of Mulberry Trees.

ALSO

The Dressing of Vines, for the rich Trade of making Wines in VIRGINIA.

Together with

The making of the Saw-mill, very usefull in *Virginia*, for cutting of Timber and Clapbord to build withall, and its Conversion to many as profitable Uses.

By *E. W.* Gent.

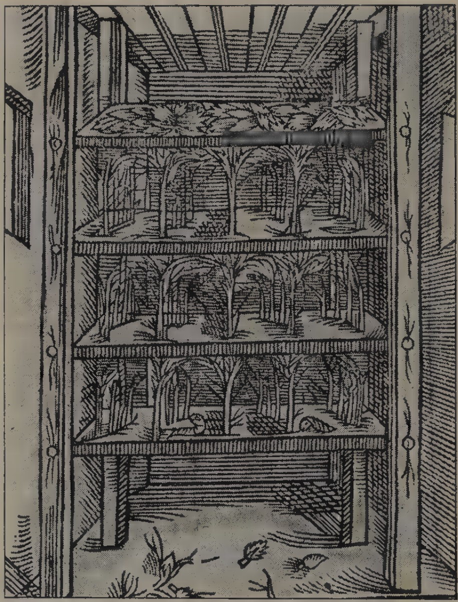
LONDON,
Printed by *T. H.* for *John Stephenson*, at the Signe of the Sun below Ludgate, 1650.

418 Title-page of the issue, London, 1650, in the New York Public Library

SILK CULTIVATION IN COLONIAL VIRGINIA

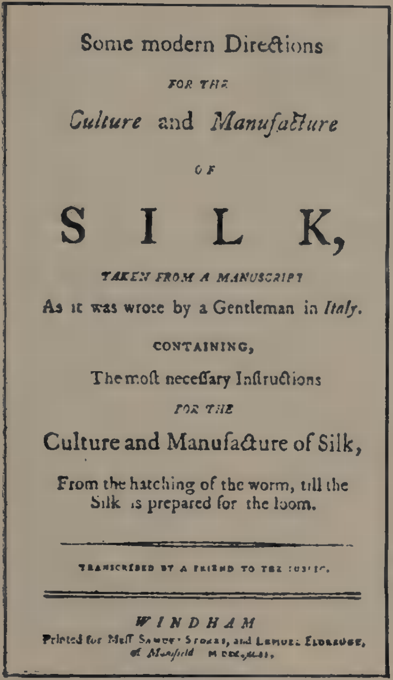
SETTLERS in a strange country must necessarily experiment for a time to discover the best adjustments to their environment. This was particularly true in the early American colonies, which, except for tobacco, indigo, and rice, yielded scarcely any commodity directly salable in the British Isles. Among many attempts to find exchangeable products, efforts to produce raw silk in America stand conspicuous. In colonial days, from New Hampshire to Georgia, enthusiasts set to work planting mulberry trees and cultivating silkworms. As a matter of fact, both these requisites for silk production were and may be grown in all but a few parts of the United States. The fact that we have never succeeded commercially in competing with China, Italy and France in silk production is not due to environment but to the lack of cheap and dependable labor. Every step in silkworm culture calls for close personal attention, and no mechanical substitute has been found for the human eye, ear, and hand in this work. In consequence, no attempts to establish the silkworm industry here have been successful; the pathetic evidence of repeated failure may be seen occasionally in the forests of the Carolinas and Georgia, where from the trees hang the cocoons made by the wild descendants of former domesticated silkworms.

The illustrations show silkworms feeding upon leaves placed on racks indoors, and the ordinary reeling process of a filature, where the cocoons are soaked in warm water to loosen the strands, and the winding of the thread on spindles and spools. The book in which these illustrations first appeared had nothing to do with America. They were, however, recopied by Edward Williams for his tract on Virginia issued in 1650, as a means of inducing colonization. Since raw silk production wherever found is the same, the American colonial silk culture probably resembled these pictures.



419 Silkworms Feeding on Racks, from *Virginia . . . Richly and truly valued*, London, 1650

420 Reeling Silk, from *Virginia . . . Richly and truly valued*, London, 1650



Some modern Directions

FOR THE

Culture and *Manufacture*

OF

S I L K,

TAKEN FROM A MANUSCRIPT

As it was wrote by a Gentleman in *Italy*.

CONTAINING,

The most necessary Instructions

FOR THE

Culture and Manufacture of Silk,

From the hatching of the worm, till the Silk is prepared for the loom.

TRANSCRIBED BY A FRIEND TO THE PUBLIC.

WINDHAM

Printed for Mess. Samuel Stores, and Lemuel Eldredge, of *Mansfield* M DCC,XCII.

421 Title-page of a pamphlet, published at Windham, Conn., 1792, in the New York Public Library

THE SILK CRAZE IN EASTERN CONNECTICUT

At no time before the Revolution, despite repeated failures, were the colonies without some silk culture. Connecticut and Massachusetts persisted tenaciously in the effort, particularly in the Connecticut and Willimantic valleys. These places succeeded in adapting at least one southern product, tobacco, and this may have accounted in part for their persistence in trying to establish the other southern industry, silk culture, in their midst.

422 Silk Mill at Gurleyville, Conn., 1827, from L. P. Brockett, *The Silk Industry in America*, New York, 1876, after a water color by C. C. Burleigh, Jr.

THE FIRST SUCCESSFUL SILK MILL, 1827

In the 'twenties and until the 'forties there was a veritable craze in the Connecticut and Willimantic valleys for raising mulberry trees for feeding silkworms. This, like all previous similar attempts to establish silk culture in America, failed. The business depression of 1837 saw its finish. But the continued interest in silk of the people of these two valleys had one important result. It led them into silk manufacture as well as raw silk production. Against manufacturing silk there is no economic bar in America. Since it is a machine industry, largely dependent upon the deftness of women workers, and inasmuch as America has always provided a ready market for silk goods, silk manufacture has thrived.

The first silk mill in America was a twelve by twelve shed built at Mansfield, Connecticut, in 1810. The same men who were interested in this enterprise constructed in 1814 a larger mill at Gurleyville, Connecticut. A third mill was constructed at Mansfield in 1821, but none proved practicable. The first silk manufacturing enterprise to meet with any degree of continued success was that of the Mansfield Silk Company, formed in 1827 and incorporated in 1829. Their mill at Gurleyville was maintained in production for ten years and so is accredited as the first successful silk mill in this country.

423 The Whitmarsh Mill, 1832, from L. P. Brockett, *The Silk Industry in America*, New York, 1876, after a water color by C. C. Burleigh, Jr.

THE SILK INDUSTRY AT FLORENCE, MASSACHUSETTS

The beginning of the silk industry at Florence, Massachusetts, goes back to 1832, when the old "Oil Mill," which for over a century had served as a gristmill, was equipped under the direction of Samuel Whitmarsh as a silk mill. In 1834 Whitmarsh and a group of investors formed the New York and Northampton Silk Company and erected a brick building to supersede the old oil mill.

GROWTH OF THE NEW ENGLAND SILK INDUSTRY

424 Nonatuck Silk Mills at Florence, Mass., from L. P. Brockett, *The Silk Industry in America*, New York, 1876

Some of the backers of the ventures already described reunited in a further attempt at silk manufacture in the early 'forties. They organized the Nonatuck Silk Company at Florence, taking the name given by the Indians to the region. Under the influence of social revolutionists such as Fourier, of transcendentalists such as Emerson and the other Brook Farm colonists, and of social reformers such as Horace Greeley, all of whom mightily influenced the thought and actions of Americans in the 'forties, the original founders of the silk business at Florence intended to run their enterprise on the communal basis, and for a time the experiment was actually tried. Before the Nonatuck Silk Company was formed, however, the community idea had been abandoned and this company from its start was the same as any other business venture.

425 The Cheney Mill at Manchester, Conn., in 1838, from a drawing by courtesy of the Cheney Silk Company

From Mansfield, Connecticut, the silk industry followed down the Willimantic valley to the towns of Willimantic and New London. From Florence the industry spread down the Connecticut River valley to Northampton, Holyoke, Springfield, Hartford, and South Manchester. Willimantic has since become famous for its thread manufacture, New London still boasts of its silk thread industry, while Holyoke saw the rise and success of William Skinner, manufacturer of satin. The early furor for mulberry trees and silkworms in the two river valleys, therefore, while never productive of raw silk, has borne profitable results in silk manufacture. At South Manchester, among the farmers who were bitten by the mulberry craze was one Cheney. His sons retained the family interest in silk and in 1838 started the Mount Nebo Silk Mills. By 1841 they were successfully making sewing silk and twist. Later they added silk ribbons and broad silks. Today they are among the best known silk producers in America. The mills cover twelve acres in an attractive village with model homes for the employees.

426 Skinner Silk Mills at Holyoke, from L. P. Brockett, *The Silk Industry in America*, New York, 1876

427 Silk Mill at Paterson, N. J. © Ewing Galloway

THE MODERN SILK INDUSTRY

Although New England has always been an important producer of manufactured silks, leadership in the industry has rested for many years with Paterson, New Jersey. It is interesting to note that the Paterson silk business was inaugurated by the same group of men who were concerned with the industry in New England.

Christopher Colt, Jr., of Hartford, Connecticut, established the first silk mill in Paterson, and in 1840 sold this little factory to G. W. Murray of Northampton, Massachusetts. Paterson soon attracted other concerns and shortly became the principal center of the industry. Paterson's supremacy is due partly to its nearness to New York City, both as a market and a port furnishing raw materials, and after its reputation was established, to the skilled labor that was attracted and held. Subsidiary silk businesses, such as the use of by-products or silk-dyeing and the building of silk-making machines, have added to Paterson's prosperity.

After Paterson was established as the leader of silk manufacture in America, a division of the industry took place, based on technical and economic differences. The weaving of silk is a highly skilled process, but there is a preliminary process for which relatively unskilled labor may be used. This part has been split off from Paterson and carried to Pennsylvania. The region of the anthracite coal mines in Pennsylvania, while giving employment to men, originally offered little occupation, outside the home, to women. Silk mills, therefore, invaded the district to take advantage of the unused female labor supply. As a result, Allentown and Scranton now press upon Paterson for leadership in silk manufacture. Paterson, however, still retains secure hold upon the second branch of silk manufacture. Pennsylvania specializes in the production of silk yarn and narrow silk, while Paterson concentrates upon the manufacture of silk goods, especially broad silk.

428 Silk Worker, Scranton, Pa., from a photograph by Lewis W. Hine

429 Opening Bales of Reeled Silk from Japan, courtesy of Cheney Brothers, South Manchester, Conn.

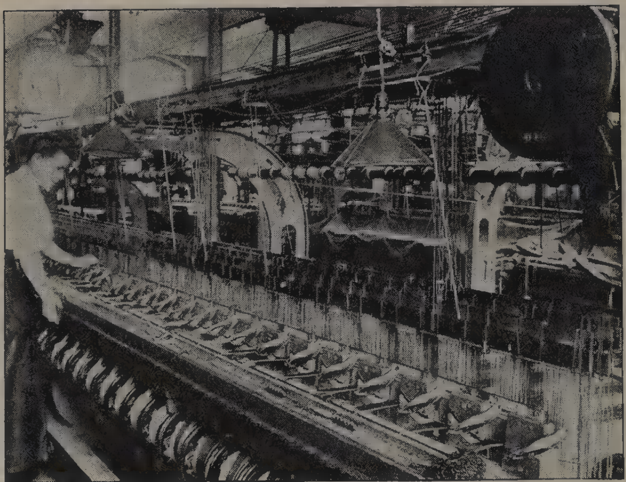
"THROWING" SILK

In the manufacture of silk goods there are three distinct stages: reeling, "throwing" and weaving. Reeling consists in unwinding the silk from the cocoon and combining the filaments from a number of cocoons into one thread. This is a painstaking task requiring deftness and skill and is generally done in the country where silk is produced.

"Throwing" is a word derived from the Anglo-Saxon "thrawan" which means "to twist." It is applied to the preliminary stages of silk manufacture and includes washing, winding, doubling, twisting, rewinding and spooling the silk. "Throwing" corresponds to "spinning" in the cotton, woolen and linen industries. The workers who perform these tasks in a silk mill are called "throwsters."

430 Winding Silk, courtesy of Cheney Brothers

431 Twisting Silk, courtesy of Cheney Brothers

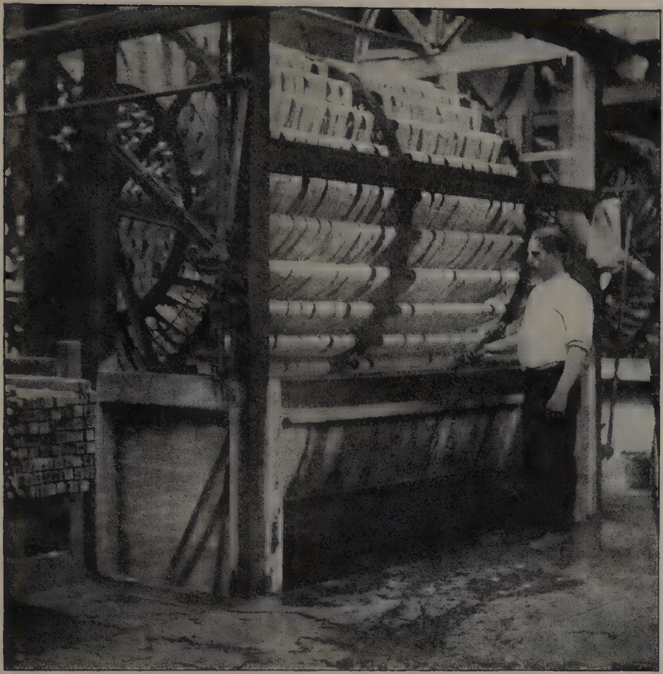


432 Narrow Silk Weaving. © Keystone View Company

WEAVING SILK

After "throwing," the silk is ready for weaving, which may be done in another mill or even another town. Weaving is of two classes, narrow silk products and broad silk goods. "Narrow silks" are such commodities as ribbons, braid trimmings and the like. "Broad silks" are generally dress goods.

Both classes are woven on looms. A narrow silk loom may weave a dozen different ribbons at once, while a loom devoted to broad silks produces but one cloth at a time. The result is the rather curious one that narrow silk looms are often larger and wider than the looms devoted to broad silks.



433 Yarn Dyeing Machine, courtesy of Cheney Brothers

DYEING SILK

The natural color of silk is cream, shaded upward to white. All other colors are obtained by dyeing. This may be done during the "throwing," that is, while the silk is still yarn; or it may await the weaving process and be done in the piece, after the goods are woven.

Thus a "throwing" factory may have a dye department just as a weaving mill may also possess one; or the dyeing may be done in a plant that specializes in this work. The latter may dye either in the yarn or in the piece. The art of dyeing is highly important and requires great skill. This is true of all textile dyeing, but is especially applicable to silk dyeing, since the material itself is so valuable that spoilage in dyeing creates great loss.

434 Piece Dyeing of Silk, courtesy of Cheney Brothers

435 Spinning Artificial Silk, courtesy of the Viscose Company, Marcus Hook, Pa.

THE SILKWORM'S SUBSTITUTE

A PRODUCT so costly and yet so popular as silk is sure to have imitations and substitutes. Most of the imitations that have been put on the market have involved cotton treated in various ways to resemble silk. One class of substitute uses gun cotton dissolved to a pulp and drawn through a small eye with a resulting thread that looks like silk. The machines that do this work in imitation of the silkworm are the only parts of an artificial silk mill that differ materially from a factory using real silk. After the silk is spun its manufacture into yarn or cloth is the same whether the silk is real or artificial. Where these imitations have been sold with the name "silk" included or suggested they have done much harm to the reputation of real silk; agitation has resulted in giving a different name to the substitute product. There is a good market and usefulness for a substitute if it is sold honestly, although none of the substitutes has the strength or endurance of real silk.

The official name adopted for artificial silk is "rayon." The business of manufacturing rayon has expanded with great rapidity since 1920, but the demand for rayon has exceeded the supply. It appears that rayon is accepted as a new textile fiber to be added to the familiar cotton, wool or linen fibers. Since rayon is now (1926) in its feeblest infancy, and since it is an artificial fiber capable of indefinite chemical modification, the future industrial historian may have many an amazing story to tell concerning it.

436 Steam Cotton Mill, Salem, Mass., from a photograph, courtesy of the Essex Institute

CHAPTER IX

TWIN GIANTS

IRON and steel are so essential a part of modern civilization that it is difficult for us to realize that the needs of our colonial ancestors were easily supplied by small local forges operated with charcoal fuel. The growth of commerce and shipbuilding in New England was the first stimulus to the development of an iron industry. Nails, bolts, anchors, distillery equipment, cannon, shot, chains, and barrel hoops, all required for New England's business, were manufactured in sufficient quantity to give to Massachusetts for a hundred years (1650–1750) the leadership in iron production.

After the Revolution a frontier market for guns, axes, plows, barrel hoops, cotton bale bands and kettles caused a development of iron manufacture in the limestone valleys that stretch almost continuously from Canada to Alabama by way of Lake Champlain, the Hudson, the Lehigh, Lancaster, Shenandoah and Cumberland valleys. In this period the districts of Salisbury, Connecticut, and Lancaster County, Pennsylvania, were notable as iron producers. A later frontier in the neighborhood of the Ohio valley created a similar pioneer iron industry, with Hanging Rock and Ironton as the smelters and Cincinnati and Pittsburgh as rolling mill centers.

Soon after 1840, with the growing demand for iron for railroad construction, as well as for general industrial purposes in the East, the first great iron industry in America was established near the anthracite coal fields in eastern Pennsylvania. Later, with the use of coke for fuel and lake ore for raw material, the industry shifted to Pittsburgh and its environs. To-day a diversified market, a growing export market, and greater freedom from technical restrictions upon location combine to create a scattered iron industry extending from Duluth to Baltimore and from Bethlehem to Birmingham. The changes in markets and location of the industry have been accompanied by advances in technical equipment; shifts in the sources and varieties of raw material, and advances in the quality, quantity and diversity of the product.

Since the Civil War has come the development of cheap and dependable steel. Steel which once found its most important use in cutlery and tools is now rolled into railway rails and built into bridges thrown across great rivers. It has become the framework of factory buildings covering large spaces and of sky-scrapers towering above city streets. It has made possible the intricate machines of the industrial era. America with its vast resources of iron ore together with its great stores of coking coal has become the leading iron and steel producing nation of the world.

Our preëminence in this industry has not been due to any outstanding genius in the inventions that advance iron and steel manufacture; indeed, we have invented comparatively few of the essential devices used in this industry. Credit for our position among the steel makers of the world is chiefly due to the quantitative demands of our

complex domestic market. The greatest single stimulus to American ironmasters has been the vast requirements of American railroads. The rails, the engines, the cars, the bridges and the buildings required to weave a net of steel over a continent have afforded a market for steel that no single nation in Europe has equaled.

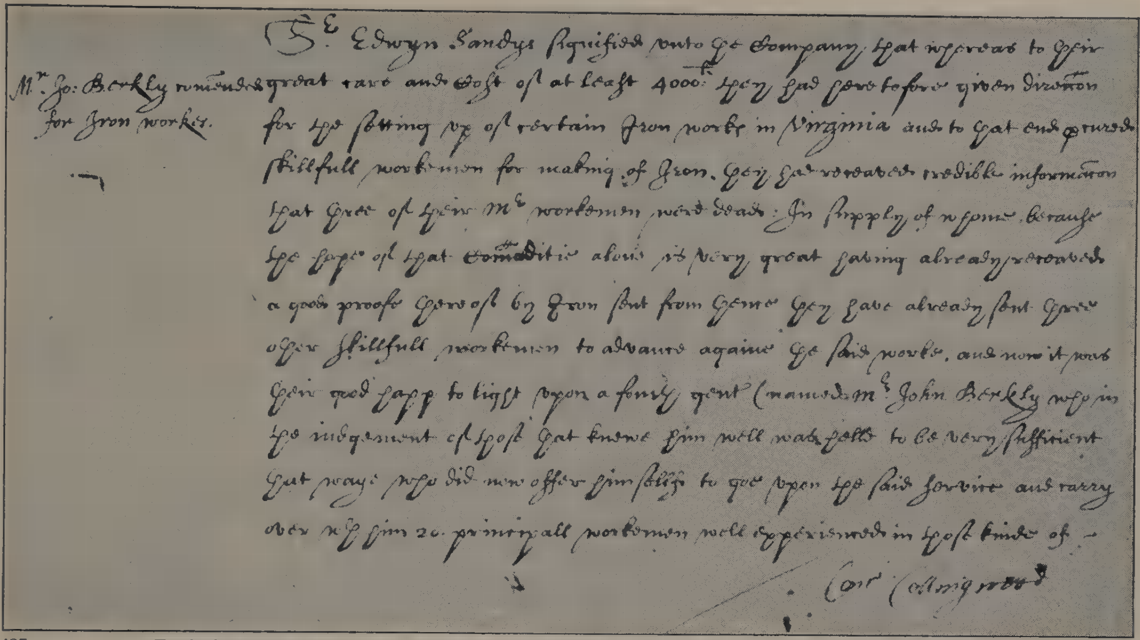
To understand the technical development of the industry it is necessary to know the principal steps in iron and steel manufacture. The raw materials for making iron are iron ore, limestone and fuel. The ore as it is found in nature is mixed with many other substances. Smelting reduces the ore to workable iron by liberating its impurities under heat. The ancient forges did not even melt the iron but rendered it viscous with many impurities still undispossessed. Thus it required reheating, hammering, and squeezing to render the iron pure enough to be used. The modern blast furnace, on the other hand, produces liquid (but not pure) iron ready for further manufacture.

The solidified commercial product of a blast furnace is called pig iron. This is the raw material for a host of different products. Before it can be manipulated, the pig is remelted in a little blast furnace called a cupola. In this process it can be treated in many varying ways so as to give iron with widely divergent qualities. Coming from the cupola, the melted iron may be cast into many forms by means of molds. The plant that does this work is called a foundry. Iron from a blast furnace may be directly cast into ingots and rolled into many shapes, or it may be put through a cupola before rolling just as it is for casting.

But iron is not steel: it differs from steel in composition, and as a result of this difference steel has qualities not found in iron. To make steel, therefore, pig iron, either liquid or in solid form, must be taken to a steel furnace. The latter may be a Bessemer, or an open-hearth or an electric furnace, all of which are shown and explained in later pages. From the steel furnaces the product pours out in liquid form. It is then cast into ingots, which are either rolled into bars, which are to steel what pig iron is to iron, or the rolling is continued until a final product is reached such as rails or bridge forms. The bar steel is sold to factories as a raw material from which scores of articles are made, ranging from wheel spokes and screw drivers to burial caskets and locomotive tires.

For especially fine steel articles, bar steel is again melted in small graphite pots called crucibles. While molten it is treated in a manner to give whatever qualities are desired. The resultant "crucible steel" is cast into forms ready for further treatment. Fine cutlery, high grade tools, watch springs, corset stays, and many other articles are made from crucible steel. The ordinary iron and steel plant contains apparatus for changing iron ore into pig iron and for converting the latter into steel. A rolling mill to thin the steel ingots into bars or finished forms is also part of the works. About the grounds also are grouped whatever other processes are incidental to these principal ones.

The story of iron and steel is one of the greatest tales in the industrial history of the United States. From the humblest beginnings to the gigantic plants of to-day has been the progress of less than two centuries. No phase of the economic development of America better illustrates the courage, the persistence, and the capacity of the American people for large undertakings.



Mr. Jo: Berkly commended for Iron works.

Sr. Edwyn Sandys signified unto the Company that whereas to their great care and cost of at least 4000li they had heretofore given direction for the setting up of certain Iron works in Virginia and to that end procured skillfull workmen for making of Iron. they had received credible information that three of their Mr workmen were dead: In supply of whome because the hope of that comoditie alone is very great having already received a good proofe thereof by Iron sent from thence they have already sent three other skillfull workmen to advance againe the said works, and now it was their good happ to light upon a sufficient gent (named Mr John Berkly who in the judgement of those that knewe him well was held to be very sufficient that waye: who did now offer himselfe to goe upon the said service and carry over with him 20. principall workmen well experienced in those kinde of -

Con Collingwood

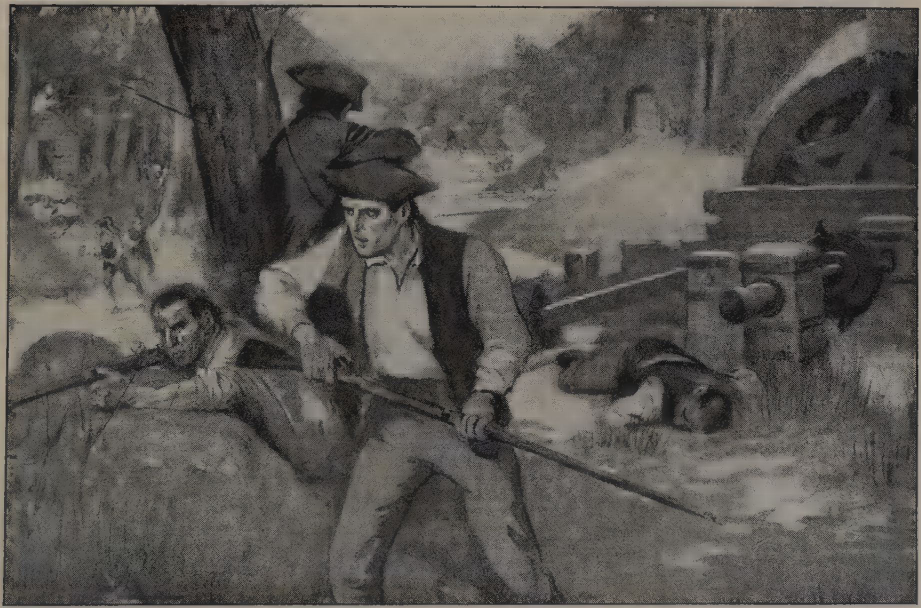
437 Facsimile from Ms. copy of the Court Book of the Virginia Company of London, in the Library of Congress

AMERICA'S FIRST IRONWORKS, FALLING CREEK, VIRGINIA, 1621

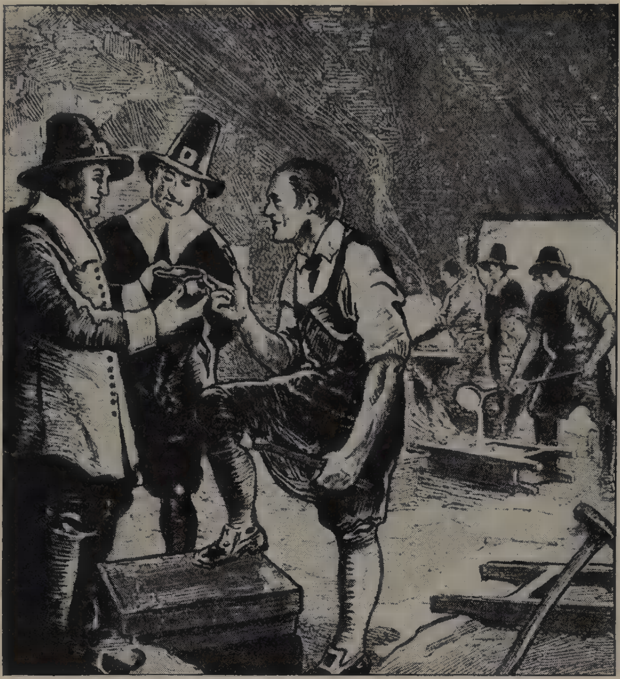
The American Indians knew nothing of iron and its uses except as occasional bits of meteoric iron were unearthed. Iron in America, therefore, is contemporary with the white man. The first discovery of iron was made in North Carolina in 1585. The Virginia colony sent iron ore to England as early as 1608, the second year of the colony's existence. Eleven years later, the Virginia Company sent a number of skilled ironworkers to Virginia who began to build a forge at Falling Creek. In 1621 the company appointed as supervisor of these works "Mr. John Berkly who in the judgement of those that knowe him well was held to be very sufficient that waye who did now offer himsellf to goe upon the said service and carry over with him 20 principall workmen."

MASSACRE AT FALLING CREEK

In 1622, during the general massacre of the inhabitants of Virginia by the Indians, the works at Falling Creek were attacked and utterly destroyed. The workmen were massacred, no one escaping but the young son of John Berkly. This event interrupted the attempts to manufacture iron in Virginia for about a hundred years.



438 From *Munsey's Magazine*, May, 1906, after a drawing by J. N. Marchand

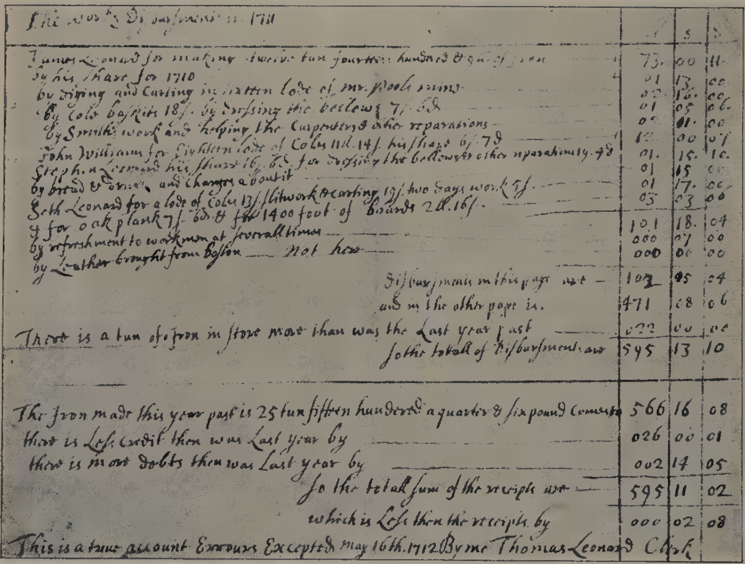


439 Casting the Saugus Pot, 1642, from a sketch made for the Old Colony Trust Company, Boston

440 The Saugus Pot, original in the Public Library, Lynn, Mass.

THE SECOND IRONWORKS, LYNN, MASSACHUSETTS, 1642

THE next important venture in iron making was in the colony of Massachusetts. Iron was discovered in meadow land bordering the Saugus River, near Lynn, about the year 1629. In 1642 an effort was made to stimulate the formation of a company to exploit the ore, and samples were sent to England as a means of interesting Englishmen in the project. Eleven men raised among them about five thousand dollars to start the work. Among the promoters were Thomas Dexter and Robert Bridges, of Lynn. In 1643 John Winthrop, Jr., came from England with workmen and raw materials and a foundry was set up on the west bank of the Saugus River on land belonging to Thomas Hudson. This was the first successful venture in iron in what is now the United States. A pot cast at this forge (No. 440) still exists and is said to have been the first casting made in America. Among the skilled workmen at the Lynn foundry were Henry and James Leonard. They themselves and numbers of their descendants were connected with so many New England iron enterprises that it was said, "Where you find ironworks, there you find a Leonard."

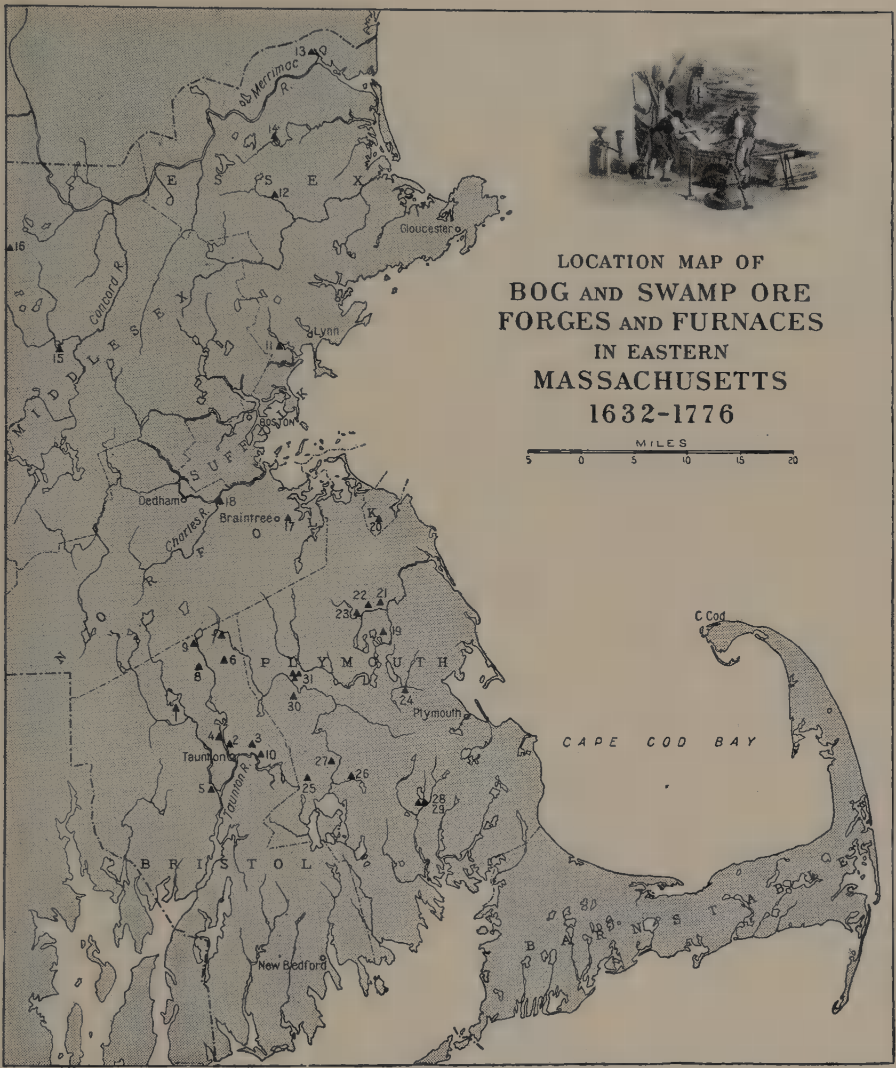


The works Disbursments in 1711	£	s	d
James Leonard for making twelve tun fourteen hundred & qu[illegible] iron	73	00	11
by his share for 1710	01	13	00
by diging and Carting in sixteen lode of mr. Pools mine	02	16	00
by Cole baskits 18/. by dressing the bellows 7/. 6d	01	05	06
by Smiths work and helping the Carpenters & other reparations	00	01	00
John Williams for Eighteen lode of Coles 11l. 14/. his share 6/. 7d	12	00	07
Stephen Leonard his share 16/. 6d. for dressing the bellows & other reparations 19. 4d	01	15	10
by bread & drink and charges about it	01	15	00
Seth Leonard for a lode of Coles 13/. slitwork & carting 19/. two days work 5/.	01	17	00
& for oak plank 7/. 6d. & for 1400 foot of boards 2l. 16/.	03	03	06
	101	18	04
by refreshment to workmen at severall times	000	07	00
by Leather brought from Boston — not here	000	06	00
Disbursments in this page are	102	05	04
and in the other page is	471	08	06
There is a tun of iron in store more than was the Last year past	022	00	00
So the totall of Disbursments are	595	13	10
The Iron made this year past is 25 tun fifteen hundred a quarter & six pound Comes to	566	16	08
there is Less Credit then was Last year by	026	00	01
there is more debts then was Last year by	002	14	05
So the total sum of the receipts are	595	11	02
which is Less then the receipts by	000	02	08
This is a true account Errours Excepted May 16th. 1712 By me Thomas Leonard Clerk			

441 Facsimile from the Ledger of the Taunton Forge for the year 1711, in the collection of the Old Colony Historical Society, Taunton, Mass.

THE TAUNTON FORGE, 1652

THE second ironworks of New England were established at Braintree in 1646 and the third at Taunton, now Raynham, in 1652. With both of these the Leonards were connected. The latter was in the hands of the Leonard family for many years and continued operation until as late as the year 1865.



442 Drawn expressly for *The Pageant of America* by Gregor Noetzel, based on research by H. M. Ehrman and I. Oggins

THE CENTER OF THE COLONIAL IRON INDUSTRY

The demand for iron products for ship gear and shipbuilding, together with iron utensils for the preparation or refining of articles of commerce, caused many forges to spring up in eastern Massachusetts during the colonial period. Between 1650 and 1750 this section offered the largest market for American iron products. Many of the forges and bloomeries erected in this period never attained the dignity of being recorded in local accounts. Others are so deeply buried in local records as to be unavailable until brought to light by the painstaking search of some local historian. The map, therefore, is as complete only as recorded material permits. The ore used in these furnaces was obtained in the bogs and swamps which were plentiful in eastern Massachusetts, particularly in Bristol and Plymouth counties. There the furnaces were thickest, successfully following the lead set by the Leonards.

Bristol County

1. Chartley Ironworks, bloomery 1696–*ca.* 1800
2. Hopewell Ironworks, bloomery 1739, slitting mill 1775–*ca.* 1782
3. Taunton Forge, bloomery 1652–1865
4. Whittington Ironworks, bloomery 1670. Replaced by cotton mill 1807
5. Small forge at Taunton line, 1695. Active through Revolution
6. Forge *ca.* 1771 by Eliphalet Leonard. First steel made here, 1776
7. Brummagen Forge at Easton, *ca.* 1720–*ca.* 1850
8. Furnace Village. First Works, 1752. Iron making still going on
9. Forge at Cranberry Meadows, Easton, 1724–1740
10. Kings Furnace, 1724–*ca.* 1839. First in colony to make hollow ware

Essex County

11. Saugus Ironworks, blast furnace and refinery forge, 1643–1688.
12. Rowley Village, 1668–*ca.* 1680
13. Amesbury Ironworks, 1710. Active through Revolution
14. Georgetown Ironworks, 1722–*ca.* 1740

Middlesex County

15. Concord Ironworks, 1660–*ca.* 1700
16. Chelmsford forge, 1706(?)–1865

Norfolk County

17. Braintree, 1646–1736. Second in colony
18. Slitting mill at Milton, 1710. Active 1750

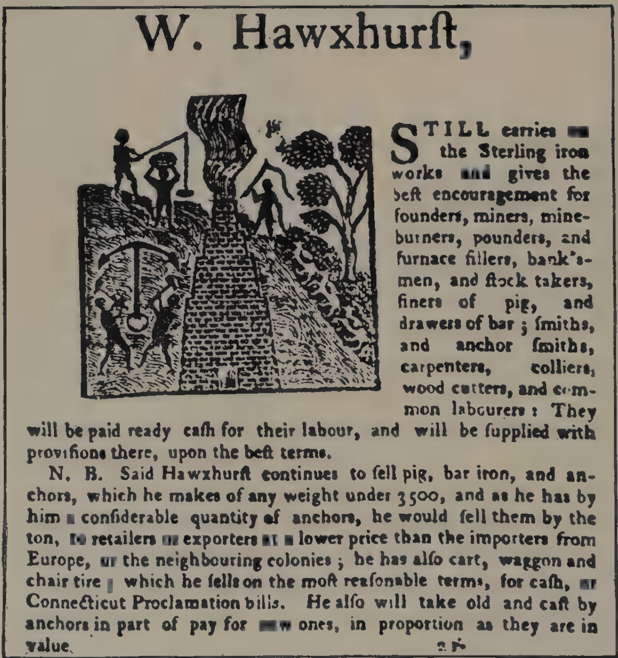
Plymouth County

19. First furnace in county, *ca.* 1702, soon abandoned
20. Bound Brook, bloomery, active *ca.* 1703
21. Barstow's forge, 1720. Active 1853 as Sylvester
22. Bardin's Ironworks, 1704. Operated to *ca.* 1870
23. Drinkwater, 1710. May have operated through Revolution
24. Holmes Forge, 1751–*ca.* 1880
25. Forge at Lakeville by Thomas Leonard, *ca.* 1700–*ca.* 1780
26. Fall Brook Furnace, 1735–*ca.* 1800
27. Slitting Mill at Middleboro, erected by Peter Oliver, 1750. Active to *ca.* 1830
28. Charlotte Furnace, 1760–1904
29. Pope's Point Furnace, 1733–*ca.* 1830
30. Gun Factory of Hugh Orr at Bridgewater, *ca.* 1742. Active through Revolution
31. Furnaces at East Bridgewater, Captain Bass, 1727–*ca.* 1884, Keith furnaces, *ca.* 1740. Active through Revolution

443 Site of the Colonial Foundry, Salisbury, Conn., from *Gleason's Pictorial*, June 10, 1854

IRON IN THE LIMESTONE VALLEYS OF NEW ENGLAND

For over a hundred years the swamp ore region of eastern Massachusetts and Rhode Island was the center of the iron industry of the colonies. In 1750 there began a development in the limestone valleys of western Connecticut and Massachusetts. The superiority of the limestone ore, together with its accessibility by way of the Hudson, Connecticut, or Housatonic Rivers, soon drew attention westward. In Massachusetts the center of production was in Worcester and Berkshire counties. In Connecticut the industry centered at Salisbury, in the Berkshire Hills, the earliest works being erected on lands that had been granted to Yale College. About thirty furnaces were built in the vicinity of Lakeville, in Salisbury township, before the year 1800. This region played an important part in the production of iron for the Continental army during the Revolution. For this reason and also on account of the superior, almost steel-like, qualities of the ore, Salisbury iron was famous in America for many years. The Salisbury iron, too, encouraged the manufacture of firearms at Springfield and New Haven. One of the first government arsenals still stands at Springfield. Hartford and Bridgeport drew the skilled arms makers of these older manufacturing centers when they later began to make revolvers.



W. Hawxhurſt,

STILL carries on the Sterling iron works and gives the beſt encouragement for founders, miners, mine-burners, pounders, and furnace fillers, bank's-men, and ſtock takers, finers of pig, and drawers of bar; ſmiths, and anchor ſmiths, carpenters, colliers, wood cutters, and common labourers: They will be paid ready caſh for their labour, and will be ſupplied with proviſions there, upon the beſt terms.

N. B. Said Hawxhurſt continues to ſell pig, bar iron, and anchors, which he makes of any weight under 3500, and as he has by him a conſiderable quantity of anchors, he would ſell them by the ton, to retailers or exporters at a lower price than the importers from Europe, or the neighbouring colonies; he has alſo cart, waggon and chair tire; which he ſells on the moſt reaſonable terms, for caſh, or Connecticut Proclamation bills. He alſo will take old and caſt by anchors in part of pay for new ones, in proportion as they are in value.

444 An Advertisement of a New York Ironmaster, from *The New York Gazette or Weekly Post-boy*, August 16, 1764

SPREAD OF IRON MANUFACTURE TO NEW YORK

In the limestone valley about the Hudson River in New York, iron manufacture became an important industry after 1750. The first ironmaster of this province was Philip Livingston, the great manor lord. In 1736 he had built a furnace at Lime Rock in Connecticut, and in 1740 he set up a furnace at Ancram Creek, Columbia County, New York. In 1750 in New York a vein of magnetic iron ore was discovered on Sterling mountain, named after Lord Sterling, the owner of the land, himself an iron manufacturer in New Jersey before the Revolution and a general in the Continental army. There were two iron establishments near Sterling mountain using the Sterling iron for anchors before Hawxhurst, whose advertisement published in 1764 is shown here, entered the business.

IRON IN THE SOUTHERN LIMESTONE VALLEYS

THE geographic continuation of the limestone valleys through New Jersey, Pennsylvania, Maryland, and Virginia, gave rise to iron manufactures in all these places at the time of the Salisbury and New York enterprises. The Principio Company of Maryland and Virginia, which is supposed to have manufactured this plate, has an interest of its own. Named from Principio Creek, an affluent of Chesapeake Bay, the company after many preliminary disappointments put its first furnace in blast in 1724 and started a forge in 1725. The Principio Company eventually built and owned several ironworks in Maryland and Virginia, among them one on the property of Captain Augustine Washington, the father of George Washington. Immediately prior to the Revolution, the Principio Company was the largest single iron manufacturer in America, the owner of four furnaces, two forges, thirty thousand acres of land and a great number of slaves and live stock. It is said that half the pig iron exported to Great Britain before the Revolution came from the furnaces of this company. The enterprise was broken up during the Revolution and the land distributed to patriots but some of the sites of the original furnaces are still the seats of iron and steel manufacture.

445 Fireback said to have been made by the Principio Company, in the collections of the Maryland Historical Society

IRON IN COLONIAL PENNSYLVANIA

As in the other colonies, the Pennsylvania ironworks were crude. A few exceptional ironmasters, mostly Germans, introduced an artistic touch into their work which distinguished it from that of the other ironworkers of the country. This plate was made by Thomas Rutter, who, about the year 1716, established the first successful ironworks in Pennsylvania. The enterprise, erected on Manatawny Creek, was called Pool Forge. Colebrookdale Furnace was erected in 1720 as an addition to Pool Forge. Rutter's descendants as well as those of his partner, John Potts, are still interested in iron manufacture in Pennsylvania.

446 A Stove Plate Cast by Thomas Rutter, in the collections of the Pennsylvania Museum, Memorial Hall, Philadelphia

"THE DEATH OF ABEL," 1741

THAT artistic iron making was not confined to a single individual is proved by another stove plate (No. 447) produced at the Durham furnace erected in Bucks County, Pa., in 1727. Biblical scenes were favorite subjects for art in iron.

447 From the collections of the Pennsylvania Museum

448 From the original owned by the James Spear Stove and Heating Company, Philadelphia

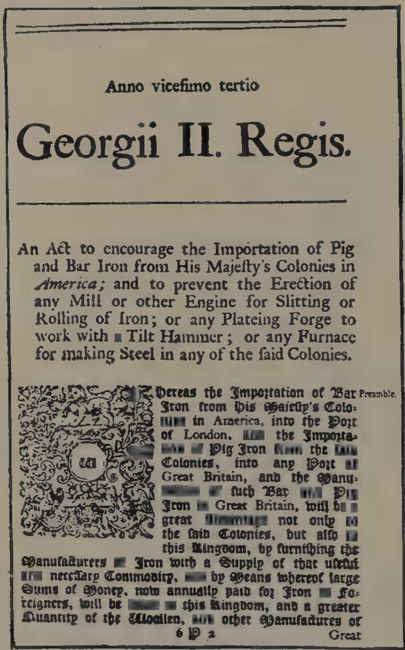
STOVE CAST BY BARON STIEGEL, 1759

One of the interesting characters engaged in iron making, in what was then western Pennsylvania, was Baron Stiegel. His ironworks were part of the incidental equipment of his estate, operated after the fashion of a German barony. Among the many stories told about him is that he commanded his ironworkers and other dependents to line the way to his house whenever he returned to it after an excursion, and to greet him with music and "hochs." Although his ironworks became famous in Pennsylvania, the Baron proved a poor business man, and the works were eventually forced to close.

449 From an engraving by Cornelius Tiebout (*ca.* 1777–*ca.* 1830), after a drawing by Strickland (1787–1854)

VALLEY FORGE IN 1812

Among the many valley furnaces in colonial Pennsylvania those that gave the name to Valley Forge have a unique place in American history. These early ironmasters building their stone furnaces little thought that in their valley would be enacted one of the great tragedies of American national history, and that the name which their activities gave to the region would come to symbolize supreme patriotic devotion.



Anno vicesimo tertio

Georgii II. Regis.

An Act to encourage the Importation of Pig and Bar Iron from His Majesty's Colonies in *America;* and to prevent the Erection of any Mill or other Engine for Slitting or Rolling of Iron; or any Plateing Forge to work with [redacted] Tilt Hammer; or any Furnace for making Steel in any of the said Colonies.

Whereas the Importation of Bar Iron from His Majesty's Colo[redacted] in America, into the Port of London, [redacted] the Importa[redacted] Pig Iron [redacted] the [redacted] Colonies, into any Port [redacted] Great Britain, and the Manu[redacted] such Bar [redacted] Pig Iron [redacted] Great Britain, will b[redacted] great [redacted] not only [redacted] the said Colonies, but also [redacted] this Kingdom, by furnishing the Manufacturers [redacted] Iron with a Supply of that useful [redacted] necessary Commodity, [redacted] by Means whereof large Sums of Money, now annually paid for Iron [redacted] Foreigners, will be [redacted] this Kingdom, and a greater Quantity of the Woollen, [redacted] other Manufactures of Preamble.

6 P 2 Great

450 From the copy, printed at London, 1750, in the New York Public Library

REGULATION OF COLONIAL IRON MANUFACTURE, 1750

Meanwhile, the progress of iron manufacture in America was watched with anxiety by the ironmasters of Great Britain. As early as 1719, frightened by the few furnaces then existing in Massachusetts, they attempted to have a law passed prohibiting the manufacture of iron in America. At the time the attempt was unsuccessful but with the growth of sentiment in favor of protection of British industries and with the increase of competition from American sources, the demand for regulation was renewed. In 1750 it resulted in the passing of a law by Parliament which prohibited the erection of any more rolling mills, slitting mills, tilt hammer forges, or steel furnaces. Bar iron, the raw material, could still be made in America and taken to England duty free, but importation was limited to the port of London. Before the knowledge of coke smelting in England the numerous forests in America gave the colonists a resource for making the raw iron not possessed by their British cousins.

By the HONOURABLE

JAMES HAMILTON, Esq;

Lieutenant Governor, and Commander in Chief, of the Province of *Pennsylvania*, and Counties of *Newcastle*, *Kent* and *Sussex*, [redacted] *Delaware*,

A PROCLAMATION.

WHEREAS by [redacted] Act of Parliament, passed in the Twenty-third Year of His Majesty's Reign, entituled, *An Act to encourage the Importation of Pig and Bar Iron from His Majesty's Colonies in* America, *and to prevent the Erection of any Mill, or other Engine, for slitting or rolling of Iron, or any plating Forge to work with a Tilt Hammer, or any Furnace for making Steel, in any of the said Colonies*; it is enacted, "That from and after the Twenty-fourth Day of "*June*, [redacted] the Year of our Lord One Thousand Seven Hundred and Fifty, every Go-"vernor, Lieutenant Governor, and Commander in Chief, of any of His Majesty's "Colonies in *America*, shall forthwith transmit to the Commissioners for Trade and "Plantations, [redacted] Certificate under his Hand and Seal of Office, containing a particular "Account of every Mill or Engine for slitting and rolling of Iron, and every plating "Forge to work with a Tilt Hammer, and every Furnace for making Steel, at the "Time of the Commencement of this Act, erected in his Colony [redacted] expressing also "in the said Certificate such of them as are used, and the Name or Names of the "Proprietor or Proprietors of each such Mill, Engine, Forge and Furnace, and the "Place where each such Mill, Engine, Forge and Furnace, is erected, and the Num-"ber of Engines, Forges and Furnaces, in the said Colony." To the End therefore that I may be the better enabled to obey the Directions of the said Act, [redacted] have thought fit, with the Advice of the Council, to issue this Proclamation, hereby enjoining and requiring the Proprietor or Proprietors, or in case of their Absence, the Occupiers of any of the above-mentioned Mills, Engines, Forges and Furnaces, erected within this Province, to appear before Me, at the City of *Philadelphia*, on or before the Twenty-first Day of *September* next, with proper and ample Testimonials of the Rights of such Proprietor, Proprietors and Occupiers therein, and sufficient Proofs whether the said Mills, Engines, Forges and Furnaces respectively, were used on the said Twenty-fourth Day of *June*, or not: And I do further hereby require and command the Sheriff of every County in this Province respectively, on or before the said Twenty-first Day of *September*, to appear before Me at the City of *Philadelphia* aforesaid, and then and there by Writings under their Hands and Seals, to certify and make known to Me, every Mill or Engine for slitting and rolling of Iron, every plating Forge to work with a Tilt Hammer, and every Furnace for making Steel, which were erected within their several and respective Counties, on the said Twenty-fourth Day of *June*, and the Place and Places where the same were erected, with the Names of their reputed Proprietor or Proprietors, and the Occupiers of them, and every of them; and whether they or any of them were used on the said Twenty fourth Day of *June*, or not, as they and each of them will answer the contrary at their Peril.

GIVEN under my Hand, and the Great Seal of the Province of Pennsylvania, *at* Philadelphia, *this Sixteenth Day of* August, *in the Twenty-fourth Year of the Reign of our Sovereign Lord* GEORGE *the Second, King of* Great-Britain, France *and* Ireland, *&c. and in the Year of our Lord*, 1750.

By His HONOUR's Command,
RICHARD PETERS, Secretary

JAMES HAMILTON.

GOD Save the KING.

PHILADELPHIA: Printed by B. FRANKLIN, Printer to the Province. MDCCL.

451 From a broadside, 1750, in the Historical Society of Pennsylvania

A COLONIAL GOVERNOR FORBIDS SLITTING MILLS

The law, while forbidding the erection of further rolling and slitting mills, permitted the continuation of those already in existence but required that a list of them be made and sent to England. As a result, the various colonial governors issued proclamations, requiring ironmasters to register and also commanding obedience to the terms of the law. The proclamation of Lieutenant Governor Hamilton of Pennsylvania bears the imprint: "Printed by B. Franklin, Printer to the Province, MDCCL."

A MASSACHUSETTS SLITTING MILL FOR SALE, 1753

The list of slitting mills in operation in 1750 made out by the Governor of Massachusetts in obedience to this act contained four names. One of these was that of the slitting mill at Milton. The existence of the mill prior to 1750 explains why it could be advertised openly for sale in 1753. Other mills, however, were erected and operated in defiance of the law.

ADVERTISEMENTS.

TO be sold, together [redacted] *seperately, the following Estate situate* [redacted] Neponset *River, in* Milton; [redacted] *slitting-Mill for the slitting of Rod-Iron, with all the Accommodations and Utensils thereto belonging: The Situation and Accommodations* [redacted] *very convenient for almost any* [redacted] *whatever: A large Dwelling House* [redacted] *the Road, well situated and accommodated for* [redacted] *Tavern, with* [redacted] *much Land (not exceeding twenty seven Acres)* [redacted] *small* [redacted] *Quantity* [redacted] *the Purchaser shall choose: Also three small Buildings* [redacted] *Shops, which may easily be removed. Enquire of* Edward Jackson, *and know further.*

452 From the *Boston Evening Post*, Dec. 17, 1753

THE IRONMASTERS IN THE REVOLUTION

As a consequence of these prohibitions the ironmasters of America were among the earliest promoters of disaffection against the English government. The Revolution was largely the product of prohibitions of manufacture and trade and the American ironmasters played an honorable part in the ultimate victory of the colonial forces. Considering the importance of iron in war it is possible to speculate on what would have been the results of the Revolution had there not existed a thriving iron industry in the colonies at the time war broke out. Even as it was, the colonial troops suffered from lack of munitions. The Cornwall (Pa.) furnace, built in 1742, was one of the important ironworks of colonial Pennsylvania.

453 Cannon and Shot Cast at the Cornwall (Pa.) furnace, 1776, courtesy of the Pennsylvania Society of the Colonial Dames of America

454 From a photograph in the possession of James Rogers, Ausable Forks, N. Y.

OLD IRONWORKS, CHAMPLAIN DISTRICT, NEW YORK

After the Revolution the development of the iron industry continued. In the northern limestone valleys the most notable development was that of the Champlain district in New York state. A beginning had been made in the exploitation of this section during the colonial period. This development received a stimulation about the year 1800 and a still greater one in 1825 as a result of the building of the Erie Canal and the opening up of the vast hinterland of western New York and the Great Lakes region. The iron of this area was manufactured for a surprisingly long time. At least one plant continued to produce until 1890. This long duration was partly the result of the excellence of the iron and partly due to the availability of forests for the manufacture of charcoal, the fuel used in making the iron.

455 From the *Report* of the Pennsylvania Department of Internal Affairs, Harrisburg, 1894

FIRST FURNACE WEST OF THE ALLEGHENIES, 1790

The main current in the development of iron manufacture after the Revolution was not northward but westward, following the pioneer trail into western Pennsylvania, Kentucky, and Ohio. The first furnace west of the Alleghenies was built in 1790 on a little stream that became known as Jacob's Creek, an affluent of the Youghiogheny. This frontier venture was named the Alliance Ironworks; its ruins may be seen to this day.

UNION FURNACE, HANGING ROCK, OHIO, 1826

Of the many early scattered iron enterprises west of the Alleghenies those that centered at Hanging Rock and Ironton became the most important. As immigration first came by way of Kentucky the earliest furnaces in the Hanging Rock district were on the south side of the river. The first furnace of this neighborhood on the north bank of the Ohio was Union Furnace, built in 1826–27 by John Means, John Sparks, and James Rogers. The furnace at first made only three or four tons of iron per day.

456 From Henry Howe, *Historical Collections of Ohio*, Cincinnati, 1847

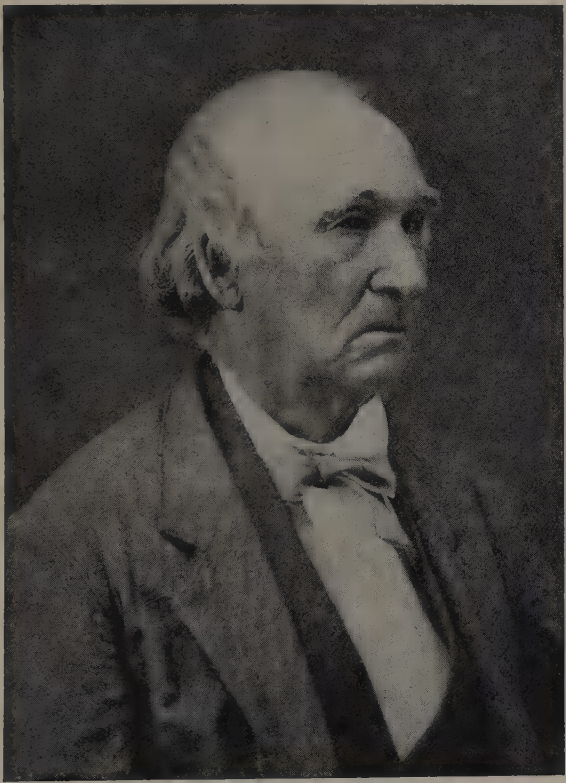
THOMAS W. MEANS, 1803–90, PIONEER OF HANGING ROCK

Thomas Williamson Means was clerk and storekeeper for the Union Furnace while his father, John, was building it, and had the honor of first firing it. In 1837 he became the half owner of Union Furnace and kept it in operation until 1885. He built or was interested in at least six other furnaces in Ohio and Kentucky. He made experiments with the hot blast, and soon after 1828 equipped the old Union for hot blast service, probably the second installation in America. No man did more for the Hanging Rock district, and no man was longer engaged or more extensively or directly concerned with the growth and prosperity of the Ohio valley iron industry.

457 From the portrait in possession of the family

JOHN CAMPBELL, 1808–91, FOUNDER OF IRONTON

John Campbell, like John Means, illustrates the westward migration of families. His ancestors moved generation by generation from Scotland to Ireland, to Virginia, to Kentucky, and to Ohio, where John Campbell was born. Campbell became identified with the Hanging Rock iron district in 1834 and was one of the first American ironmasters to use the waste gases from a furnace to run boilers, and also the first to operate a furnace with a hot blast. Campbell organized and became the president of the Ohio Iron and Coal Company, which bought the land, planned and built the town of Ironton, near Hanging Rock.



458 From a photograph, 1890, in the possession of Mrs. Julius Anderson, Ironton, O.

JOHN CAMPBELL'S FAMOUS HECLA FURNACE

The Hecla Furnace, one of the properties of John Campbell in the Hanging Rock area, was famous for the quality of its iron. Its output was not only in demand for machinery and car wheels but also for ordnance. Guns and armor plate made from Hecla iron were used during our Civil War and in the Crimean War. The celebrated gun known as the "Swamp Angel" of Charleston harbor was cast from Hecla iron.

459 From Henry Howe, *Historical Collections of Ohio*, Centennial edition, Cincinnati, 1904, after a drawing by J. N. Bradford

460 From a contemporary woodcut in the collections of the Historical and Philosophical Society of Ohio, Cincinnati

AN EARLY STEEL PLANT, CINCINNATI, 1832

Cincinnati, the immigrant gateway to the frontier and for fifty years the largest inland city in America, was an admirable location for an iron industry. Lacking ore, Cincinnati depended upon the Hanging Rock district for pig iron which was converted into iron tools, utensils, stoves and the like in the foundries and rolling mills of the city. Iron working early became one of the leading activities of Cincinnati. Next to Cincinnati the best location for frontier iron industry was Pittsburgh, which used pig iron from Juniata and the upper reaches of the Monongahela River. The first rolling mill appeared in Pittsburgh in 1812, and thereafter until 1859 all of Pittsburgh's interest in iron manufacture was in the secondary processes of converting pig into useful articles.

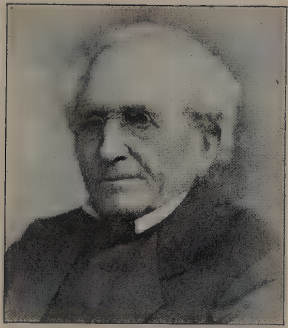
461 The Lehigh Crane Ironworks, from M. S. Henry, *History of the Lehigh Valley*, Easton, Pa., 1860, after an ambrotype by P. H. Osborn

INTRODUCTION OF ANTHRACITE IRON, 1840

During the period of westward migration, the East was also becoming more thickly settled, new manufacturing enterprises using iron machinery were multiplying rapidly, public works were being pushed forward extensively, and railroads were demanding increasing quantities of iron. All these factors combined to stimulate increased production by eastern iron manufacturers. The gradual failure of charcoal fuel fixed attention upon substitutes and eventually anthracite coal proved itself a satisfactory fuel. Fortunately, the anthracite mines were almost in the center of the eastern iron-consuming market, and canals from the mines to tidewater made transportation easy. The Great Valley iron and lime deposits were close to the anthracite fields, and from 1855 to 1875 iron smelted with anthracite formed the largest part of iron production in America. The first plant to manufacture iron successfully with anthracite was the Lehigh Crane Ironworks, established in 1840 at Catasauqua, Pennsylvania, by David Thomas, the founder of the American anthracite iron industry.

DAVID THOMAS, 1794–1884, THE FATHER OF AMERICAN ANTHRACITE IRON

DAVID THOMAS was born at Tyllwyd, South Wales, in 1794. He early became interested in the semi-anthracite of Wales and made many experiments in its use as a fuel for the manufacture of iron. His success induced the Lehigh Coal and Navigation Company to send for him to come to America and make similar experiments with their anthracite coal. As superintendent of the Lehigh Crane Ironworks, he is said to have received at first a salary of but twenty dollars a week with the promise of an additional five dollars for each new furnace built. Thomas projected a number of other furnaces in the anthracite region, and had much to do with the development of the iron industry here. He introduced the "hot blast" stove in America. (See page 190.)

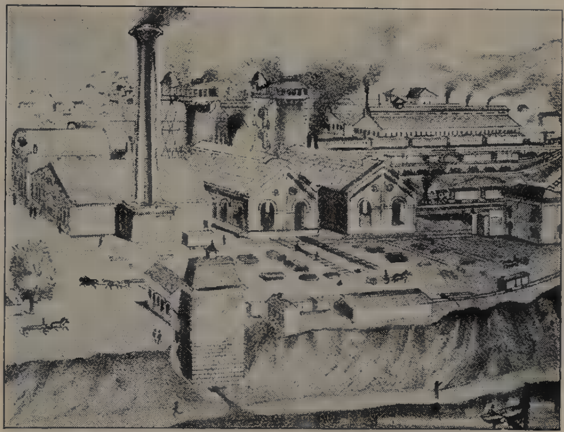


462 From a photograph, 1878, in the possession of the Thomas Iron Company, Hokendauqua, Pa.

463 From a photograph, about 1875, courtesy of the Bethlehem Steel Company, Bethlehem, Pa.

THE LACKAWANNA STEEL COMPANY AT SCRANTON

THE most famous of the steel companies that used anthracite as fuel was the Lackawanna Steel Company. The original plant of this company was located directly over anthracite coal mines at Scranton, Pennsylvania. The present works are at Buffalo, New York.



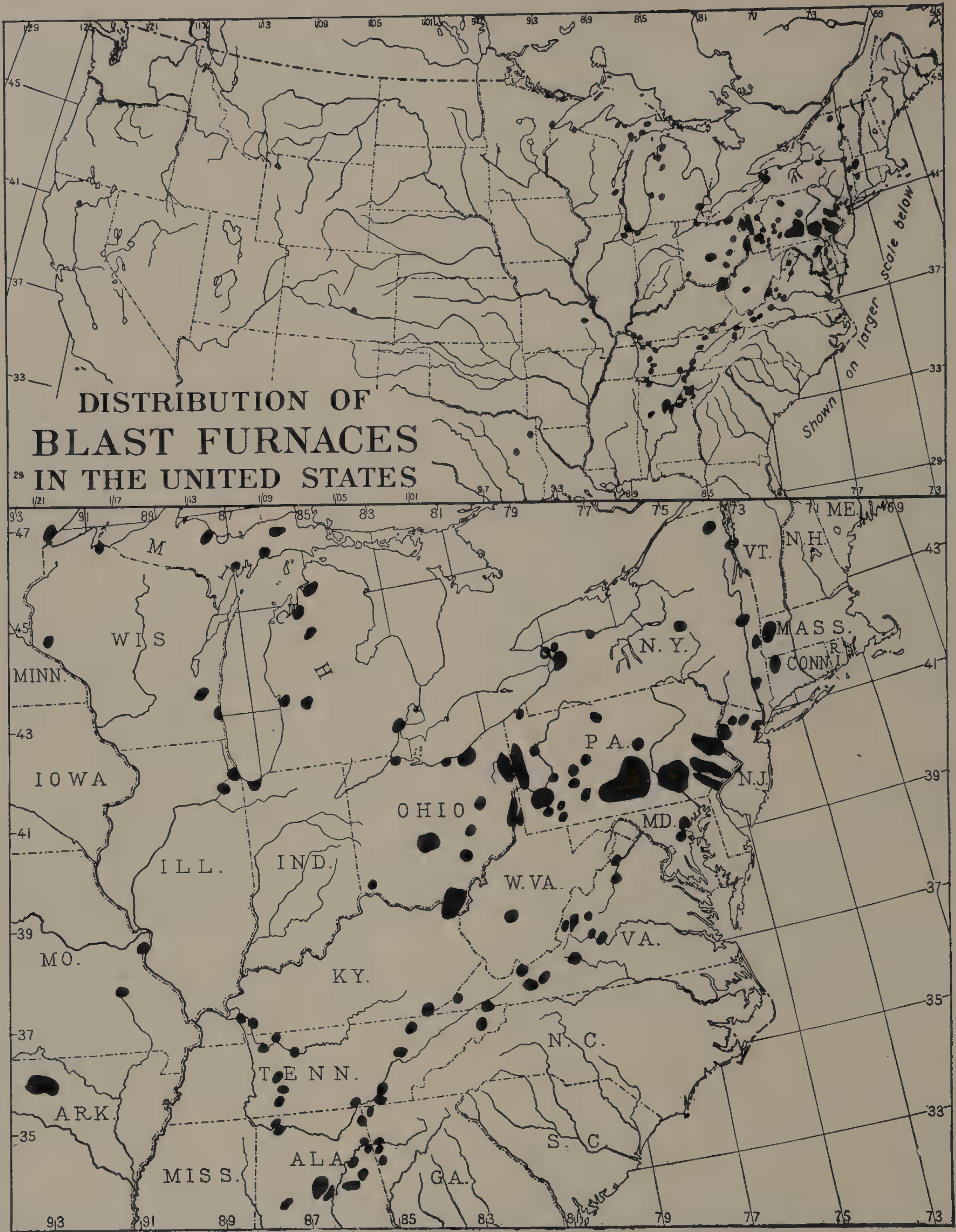
464 Jones & Laughlin's American Works at Pittsburgh, from the *History of Allegheny County, Pennsylvania*, Philadelphia, 1876

PITTSBURGH IRONWORKS, 1876

AFTER 1870 the center of the iron industry again shifted. The main reason for this was the replacement of anthracite coal by coke as a fuel for the manufacture of iron. Since the best coke was obtained at Connellsville, near Pittsburgh, and inasmuch as coke could not be shipped great distances without breaking into dust, it was imperative for the iron industry to move near the source of fuel. The introduction of Minnesota ore, and the changing of the principal railroad market for iron from the East to the states of the corn belt made the city of Pittsburgh, for a generation, the hearth of the nation. The development of the Pittsburgh industry came at a time of tremendous national expansion in every field of endeavor. This growth demanded iron. Greater output of iron was an immediate pressing necessity. Output increased from thirty-five tons a day in 1860 to fifty tons a day ten years later. Within five years this figure was doubled and then within five years doubled again. By 1890 the daily output was three hundred tons and in 1917 a furnace poured forth one thousand five hundred tons of iron in a day.

465 Carnegie's Famous Lucy Furnace, from the *History of Allegheny County, Pennsylvania*, Philadelphia, 1876

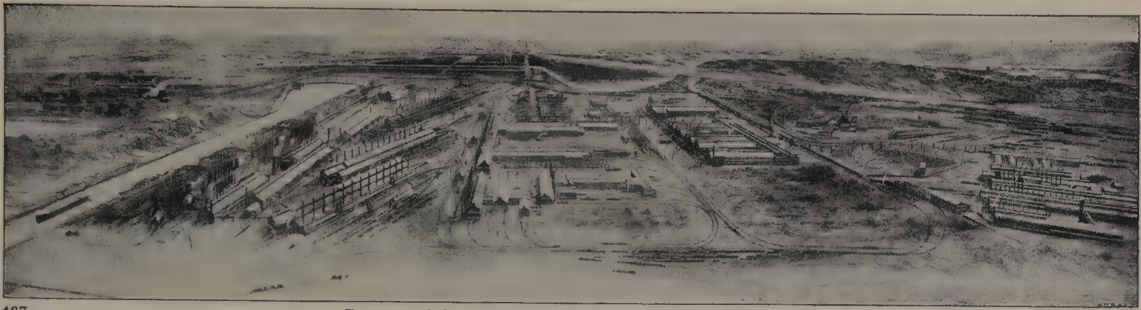
One of the most famous furnaces, forced madly to establish records of output that lasted but a few hurried days, was the Lucy furnace of the Carnegie Company. This furnace used coke, and began its record-breaking career in 1872. In 1874, for the first time in iron-making history, it turned out one hundred tons of iron in one day. The Lucy furnace captured most often the symbol of victory, a broom fastened to the stack as evidence of a clean sweep.



466 Drawn expressly for *The Pageant of America* by Gregor Noetzel from data compiled in 1908 by W. T. Thom of the United States Geological Survey

THE IRON AND STEEL INDUSTRY

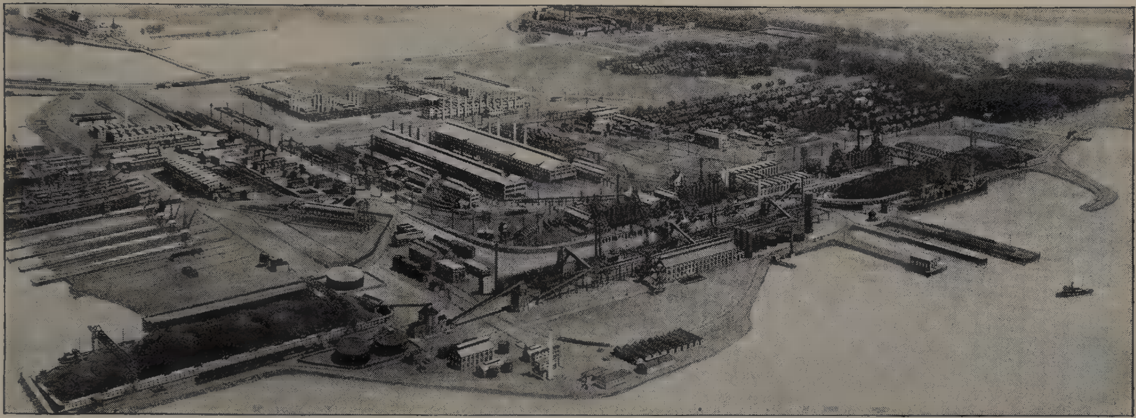
TIME has again wrought changes in the steel industry. The by-product coke oven makes it possible to manufacture coke anywhere, and the necessity of putting a furnace near a coking coal deposit no longer exists. Not being shackled to a special region, the iron and steel industry of the country now has its plants on the shores of the Great Lakes and on the coast of the Atlantic. They are found as far south as Alabama and as far west as California. The industry, however, is concentrated east of the Mississippi because there the market is largest.



467 Courtesy of the United States Steel Corporation, New York

THE GARY STEEL WORKS, GARY, INDIANA

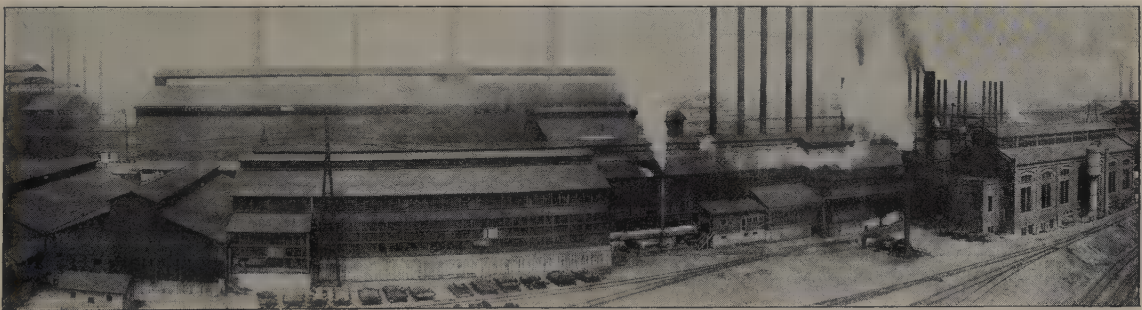
One of the favorite spots for the manufacture of iron for the domestic market is along the shores of the Great Lakes. The domestic market has moved west of Pittsburgh and is now best reached from the Middle West. Nearness to the ore of the Great Lakes and the large amount of space available for physical expansion led to the creation of the great works at Gary, Indiana, now the largest in America.



468 From a drawing by Ernest W. Spofford, courtesy of the Bethlehem Steel Company

STEEL PLANT AT SPARROWS POINT, MARYLAND

Iron and steel for export or for the eastern market can advantageously be manufactured along the Atlantic seaboard, especially when the by-product coke is used and ore imported from Cuba or Spain. These are among the advantages of the Sparrows Point plant near Baltimore.



469 Courtesy of the United States Steel Corporation

STEEL WORKS AT ESTLEY, ALABAMA

In the neighborhood of Birmingham, Alabama, is found the only superlative situation for an iron and steel plant in America. There alone the coal, iron ore, and limestone are found together. The works at this point, now part of the United States Steel Corporation, send their products throughout the Southwest, into the Atlantic coast markets and into foreign trade.

470 Bed Ore (left), and Melted Ore (right), picked up in the neighborhood of Falling Creek, Va., now in the Virginia Historical Society Collections

THE MINING OF IRON

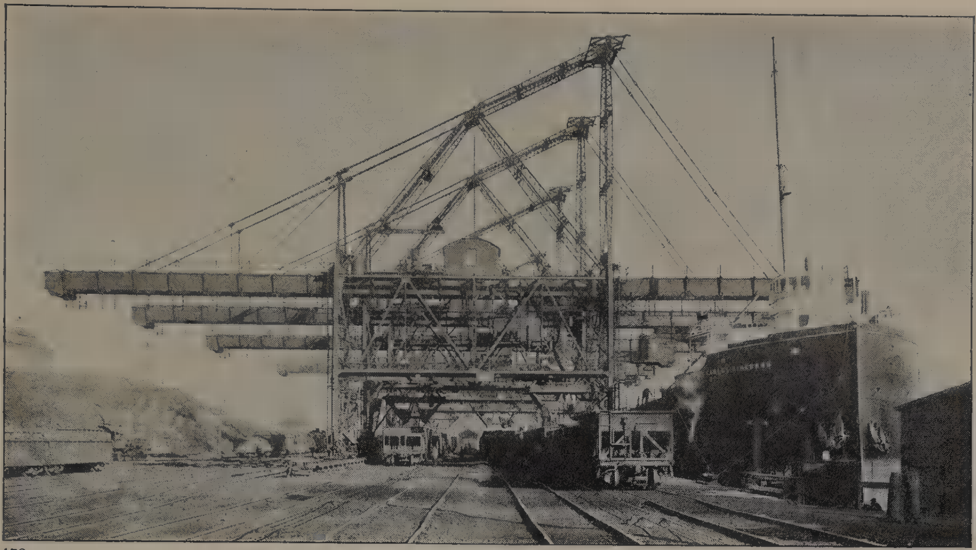
THE bog ore upon which the colonial furnaces operated was dug from swamps or shallow ponds by a man in a boat with an oyster rake. Two tons a day was a large amount to be gathered. The modern American iron mine in Minnesota scoops its ore with a steam shovel at the rate of six thousand tons per day. To expose the ore, as much overlying soil and rock has been removed from the Minnesota ranges as was dug to make the Panama Canal. American iron mining is the cheapest mining in the world, and the ores rank among the highest. In these facts is to be found the explanation of the world leadership of our iron and steel industry.

471 Open-Pit Iron Mine, Minnesota, courtesy of the Oliver Iron Mining Company, Duluth

472 Courtesy of the United States Steel Corporation

IRON ORE DOCKS, DULUTH, MINNESOTA

THE ore is brought by train from the mines north of Duluth and dumped into enormous receiving docks. The trains run on the top of the dock and the ore slides into great bins below the track level. These bins are considerably above water level and a chute from the bin fills the ore boat by gravity. The boat then sails to one of the lower lake ports where the ore is received for the furnaces.



473 Courtesy of the Brown Hoisting Machine Company, Cleveland, Ohio

UNLOADING AT CONNEAUT ON LAKE ERIE

THE ore boats loaded by gravity at Duluth are unloaded by machinery at the lower lake port. A long steel arm projects over each hatch of the boat. The arm is a runway for a great bucket which slides by a cable from the steel arm into the boat and is filled mechanically with ore. It is then hauled up to the arm and runs back along it. The traveling bucket may stop in the middle of the arm and dump its ore into a railway car standing under the arm, or the bucket may continue to the end of the arm and dump its load upon a reserve pile from which it will be loaded into cars later.

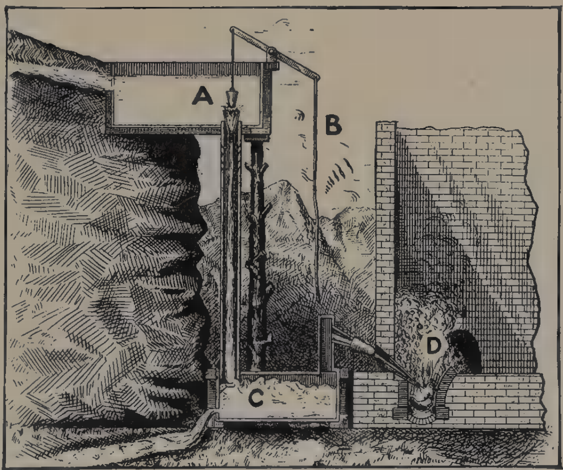
474 From *The Growth of Industrial Art*, Washington, 1892

A PRIMITIVE FORGE

THE central interest in the manufacture of iron is the apparatus which converts the ore into metal. The oldest forges were crude hearths on which the ore was piled and partly melted by the heat of wood or charcoal combustion. The idea of a draft to hasten combustion was soon applied to iron manufacture and from this idea developed the crude bellows used to blow the early forge fires.

CRUDE FORGE WITH TROMPE

THE early bellows operated by hand or foot furnished an unsatisfactory draft. For a better draft a trompe was invented. In this device an intermittent flow of water and air into a pipe was arranged by means of a valve (A). The suction of the water closed the valve and a spring on a balance (B) attached to the valve opened it again. The mixed air and water was led into an air-tight box (C) where the air escaped under pressure from the water below. The air under pressure was then conducted to the fire box (D) by means of a nozzle. This device was in use for centuries in Europe.

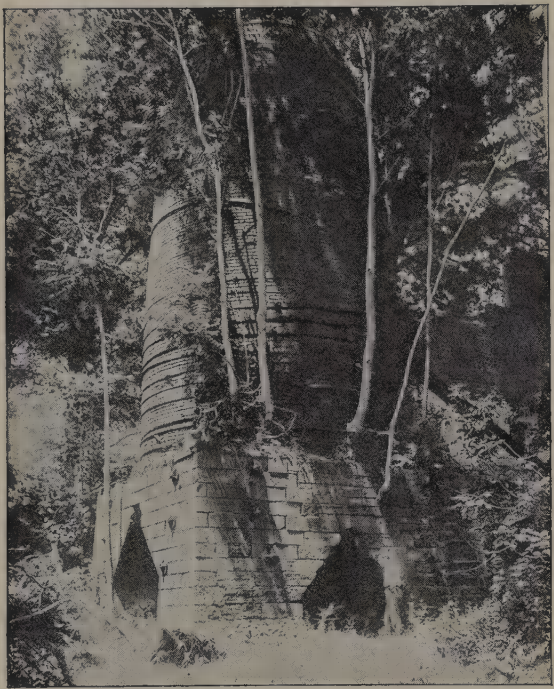


475 From *The Growth of Industrial Art*, Washington, 1892

THE CATALAN FORGE

The earliest forges erected in America showed but little improvement over the crude forges of Europe. One of the commonest types was known as the Catalan forge, which got its name from the province of Catalonia in Spain where the forge was first a commercial success. These crude forges survived in isolated parts of the country long after they had been replaced elsewhere by more efficient forges.

476 Ruins of a Catalan Forge, Talladega Creek, Alabama, from a photograph by R. S. Hodges of the Geological Survey of Alabama



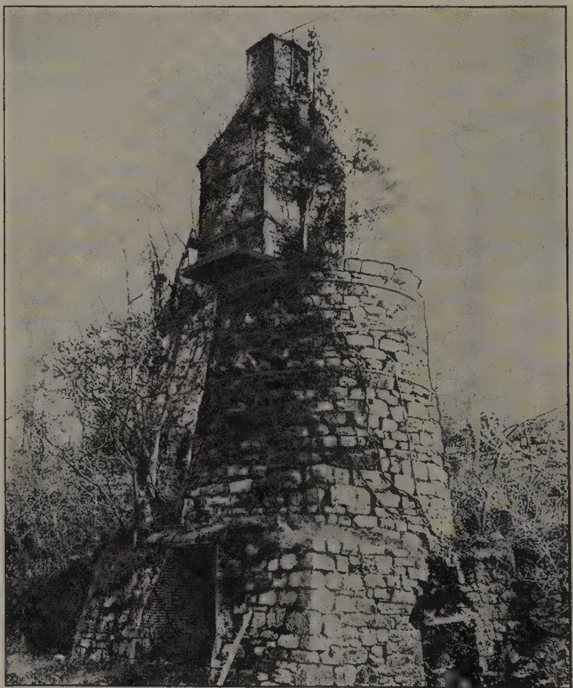
477 Ruins of a Cold Blast Furnace built in 1830, courtesy of Richard Peters, Jr., Philadelphia

THE COLD BLAST FURNACE

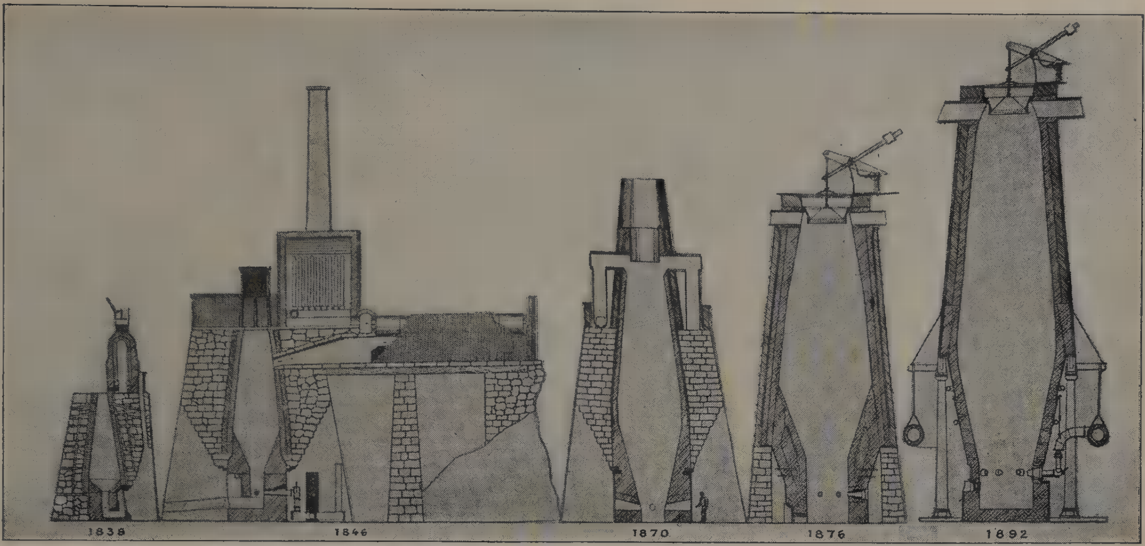
The application of water power to the operation of the bellows requires a fairly elaborate mechanism, and its application, although known from European practice, could not be widely made until the industry was fairly well established. By 1750 water power was being generally applied in this country. Water-driven bellows enabled the ironmaster to produce a far better draft than he had ever been able to secure with hand bellows. This in turn enabled him to pile more ore on his furnace and so build a higher and larger furnace than before. This larger and higher furnace is known as the "cold blast" furnace, as distinct from the later "hot blast" furnace, and by 1788 was producing fifteen and one half tons of iron a week.

THE HOT BLAST FURNACE

When David Thomas came to America to introduce the use of anthracite coal in the manufacture of iron, he brought with him the idea of the "hot blast." In the cold blast furnaces, the air current was introduced directly into the furnace at the temperature of the atmosphere. The idea behind the hot blast was the utilization of the hot gases arising from the smelting process to heat the air before it was blown into the furnace. The hot blast saves fuel in the smelting process because none of the furnace heat is used to bring the air to the burning point. The earliest method of heating the blast was to collect the gases in a stove at the top of the furnace and pipe the air to the blowing apparatus while the used gases escaped through the chimney. Note the stove perched on top of the furnace.



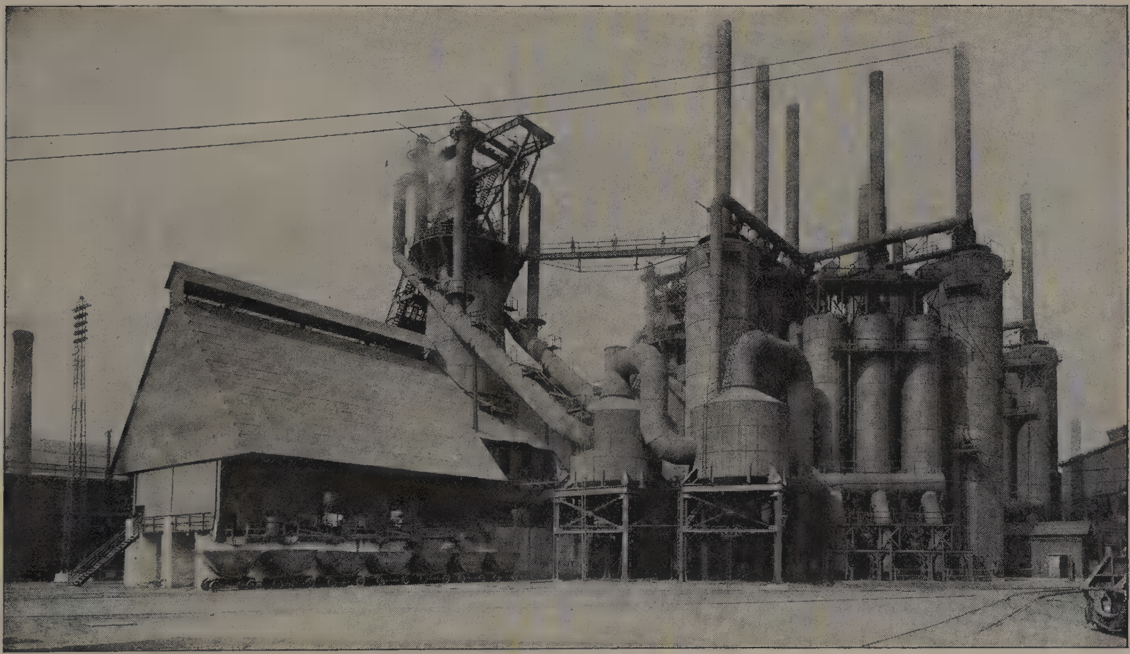
478 Ruins of a Hot Blast Furnace, York County, Pa., courtesy of Richard Peters, Jr.



479 From the *Report* of the Pennsylvania Department of Internal Affairs, Harrisburg, 1894, after a drawing by John Birkinbine

THE DEVELOPMENT OF THE BLAST FURNACE, 1838–92

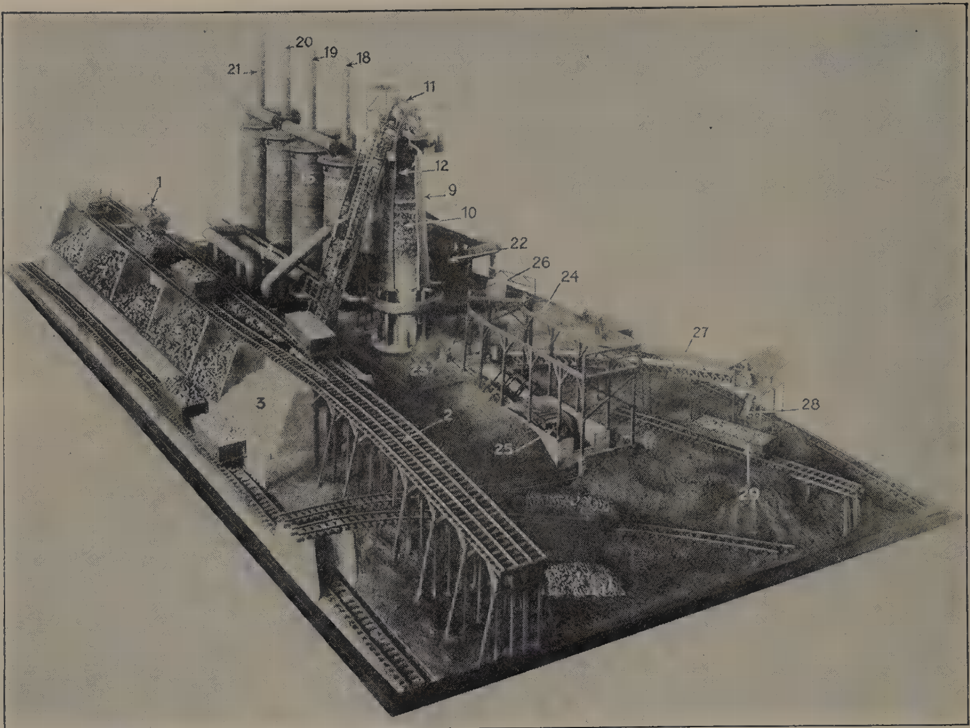
THE development of the furnace since the introduction of the hot blast has been largely in the direction of increased capacity. This has been made possible by adding to the height and girth of the furnace, and increasing the smelting of a correspondingly large amount of ore.



480 Courtesy of the Bethlehem Steel Company

A MODERN BLAST FURNACE

A MODERN blast furnace with its accompanying apparatus is a massive piece of machinery far different in appearance from the simple stacks from which it originated. It is correspondingly expensive. The smallest plant for making iron or steel according to modern practice requires an investment of at least twenty million dollars. This is one reason why iron making is now a large-scale industry in contrast with its small-scale local character in the earlier part of the nineteenth century.



481 From a model in the Commercial Museum, Philadelphia

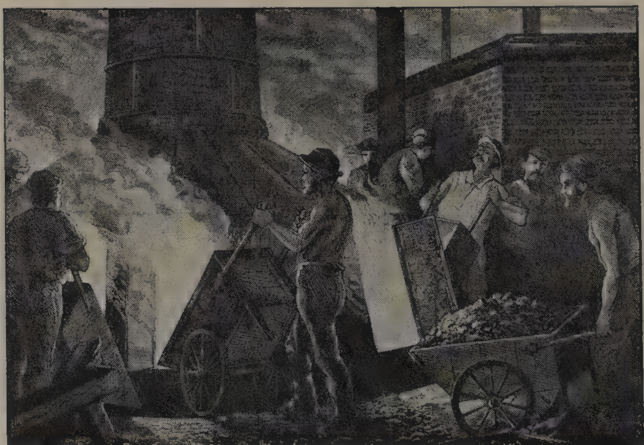
HOW PIG IRON IS MADE

A MODEL of a blast furnace may help clarify the process of making pig iron. (1) is a railroad car bringing fuel, flux material and ore to the trestle (2) where it is then dumped into the storage bins (3) to (8). (9) is a cylindrical furnace lined with fire bricks and usually about 22 feet inside diameter and filled with a thick bed of fuel, flux, and ore (10) which is introduced into the furnace by a hoist (11) and dumped into the top at (12).

The hot gases given off are taken away through the pipe (13) and introduced into the stoves (14) to (17) having chimneys (18) to (21). These stoves are filled with fire bricks laid checkerboard fashion and the heated gases pass up through the stoves and in so doing heat the fire bricks. After the fire bricks have been thoroughly heated, the gas is shut off and the air is heated by being drawn over the hot brickwork. This heated air is then introduced into the furnace from the pipe (22). At intervals the melting cast-iron is drawn off at the point marked (23) and may run out into the open depressions made on the sand floor (24) and be cast into pigs or delivered to the mechanical mixer (25). From the mixer it is elevated by the crane (26) and poured into the casting machine (27) which is merely a long endless chain having a large number of forms. In the forms the iron is cooled and finally solidified and then dumped on to the chute (28) and finally into the railroad car (29).

FILLING A FURNACE BY HAND

COAL and coke, ore and limestone were once dumped into the top of a blast furnace by hand wheelbarrows. The task was heavy and required many laborers. As much water was required in making iron, most furnaces were located on a river, usually close to one side of the valley so that the top of the furnace was nearly level with a nearby hill. It was then feasible for men to push loaded wheelbarrows to the top of the furnace. When a convenient hill was lacking, a trestle equaling a hill in height was made.

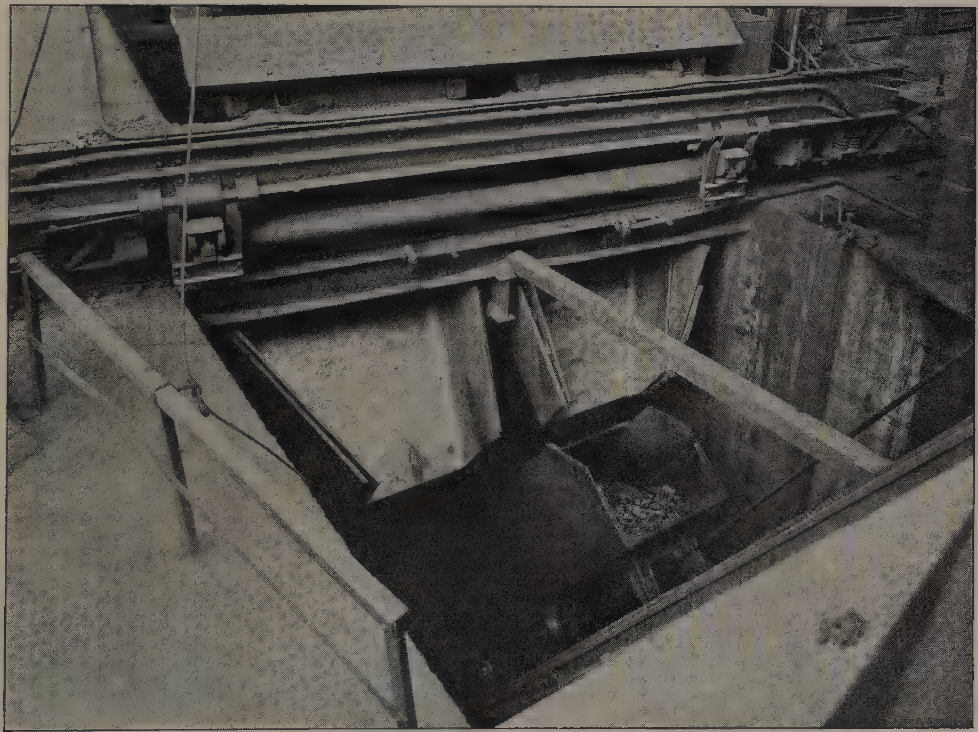


482 From *Harper's Weekly*, Nov. 1, 1873

483 From a photograph taken in 1881, courtesy of Richard Peters, Jr.

INCLINED PLANE FOR HOISTING RAW MATERIALS, 1881

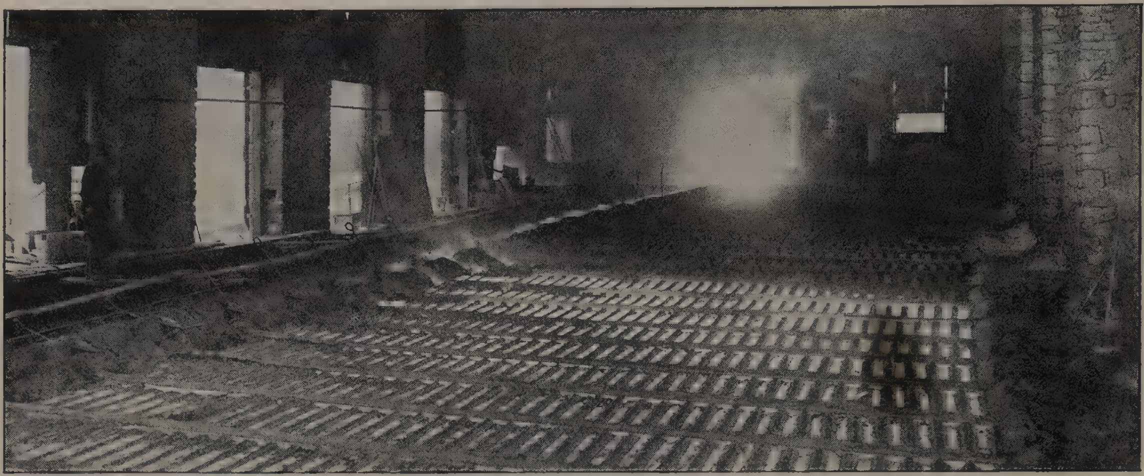
VERTICAL hoists first superseded hand dumping and where room permitted, the vertical hoist gave way to the inclined plane. In one of the early attempts in Pennsylvania to use the inclined plane, loaded cars were hauled up the plane and their contents dumped into the top of the furnace.



484 Courtesy of the Bethlehem Steel Company

MECHANICAL "SKIP" FOR FILLING A FURNACE

IN modern methods of filling a blast furnace, the correct proportions of coke, limestone and ore are mechanically measured and dumped into a waiting bucket on wheels called the "skip." The skip is then drawn up an inclined plane to the top of the furnace where the contents are automatically spilled into the furnace.



485 © Rau Studios, Inc.

CASTING IRON IN SAND

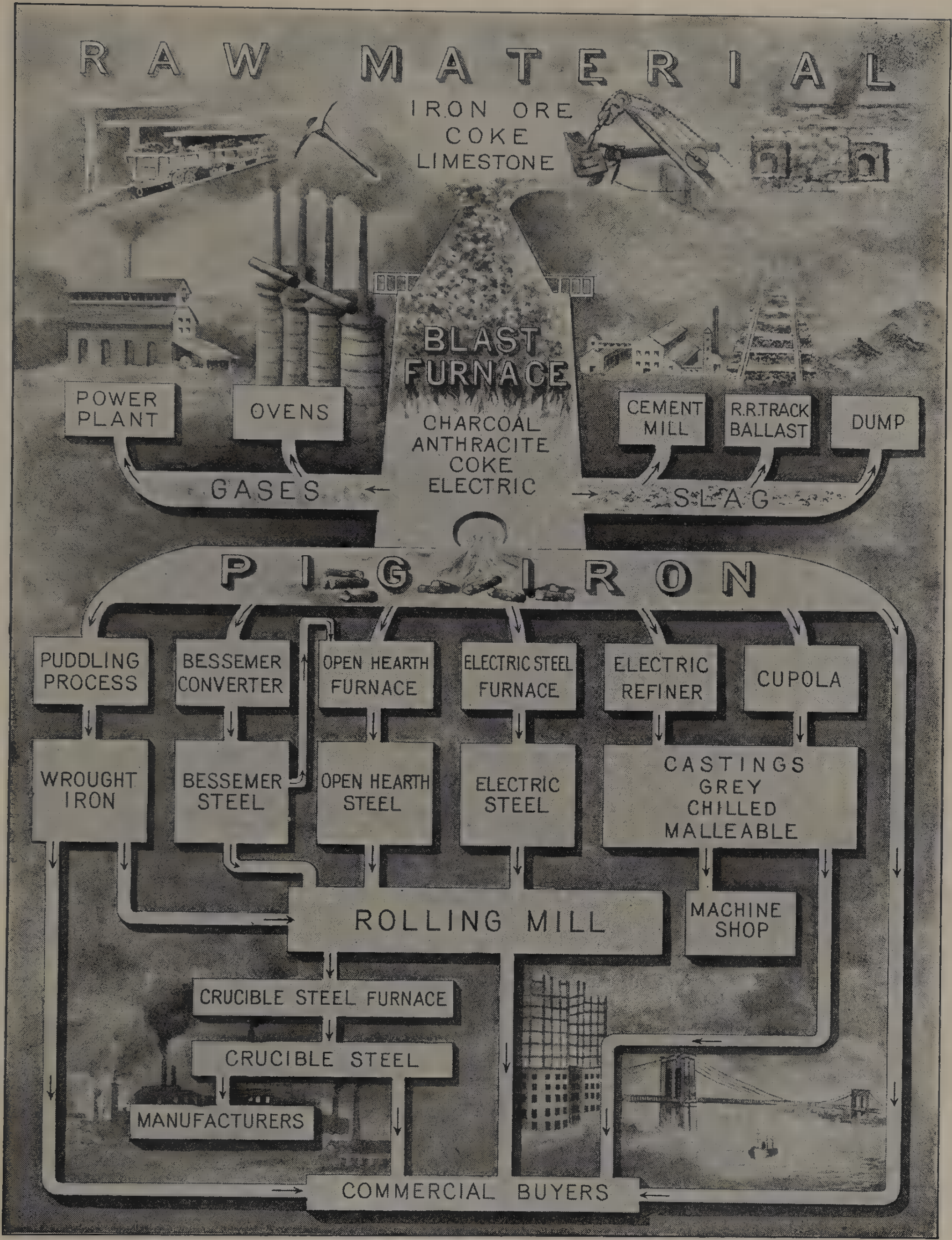
After the furnace operation is completed the liquid purified iron is drawn from the furnace. This operation is called "tapping." According to the old method — and one sometimes now used — the melted metal was run into a main sand channel, and thence into smaller lateral channels from which it was directed into rows of open sand molds. The pattern made by this arrangement somewhat resembled a mother pig feeding her young, so the cooled iron in the laterals was called "sow iron" while the smaller chunks in the sand molds were named "pig iron."

486 Cooling Iron in Molds. © Keystone View Company

THE MODERN PIG CASTING MACHINE

The sand casting floor consumed both room and time, and modern industry generally uses a pig casting machine. Metal pig molds are placed upon a moving chain and red-hot liquid iron poured into them. As the molds slowly advance the iron is cooled by contact with the air and sprays of water. At the end of the journey the cooled iron is dumped out of the molds by gravity into waiting railroad cars.

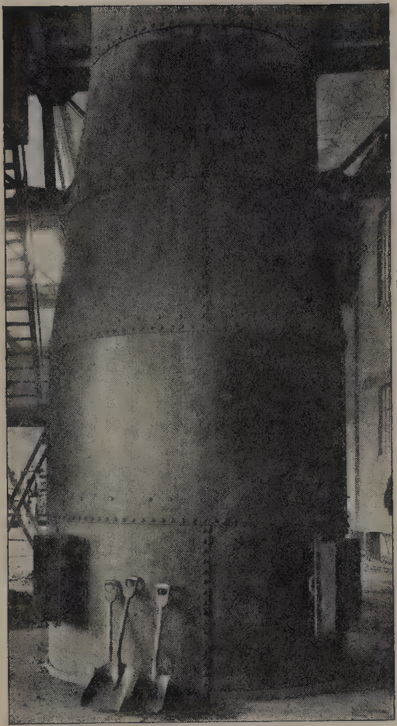
487 General View of a Pig Casting Machine, courtesy of the Bethlehem Steel Company



488 Drawn expressly for *The Pageant of America* by Gregor Noetzel, American Geographical Society, New York

FROM IRON MINE TO FINISHED PRODUCT

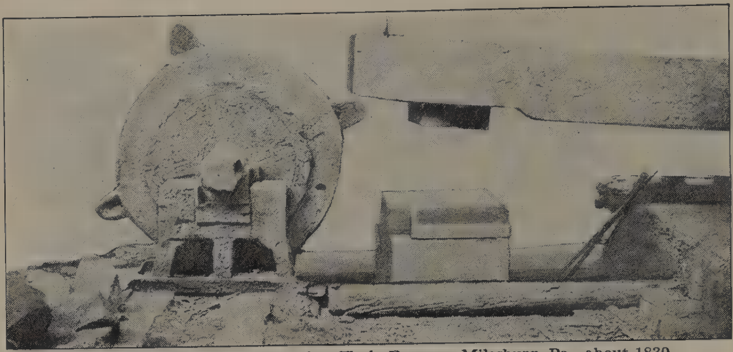
To a novice the manufacture of iron and steel seems a complicated, planless repetition of processes. Yet when one has visualized the whole manufacturing story, it is easy to see that each process fits into a proper sequence and has an exact relation to all other processes. The illustration shows that there are three main stages in the production, one having to do with the blast furnace — reduction of ore — one concerned with the making of iron and steel in crude forms and, finally, one that perfects the raw iron and steel for more nearly usable purposes. Blast furnace, steel mill and rolling mill are the three main divisions of a steel plant. When we speak of an iron and steel plant, we mean one that has these three divisions.



489 Courtesy of the Bethlehem Steel Company

CUPOLA FOR REMELTING IRON

THE manufacturer of iron buys pig as his raw material. This must then be melted and treated in a small blast furnace called a cupola. A foundry always has its own cupola; so also does a plant manufacturing saws. Edge tool works are likely to possess a cupola, likewise nearly all plants making machinery are apt to have their own foundry with its cupola.



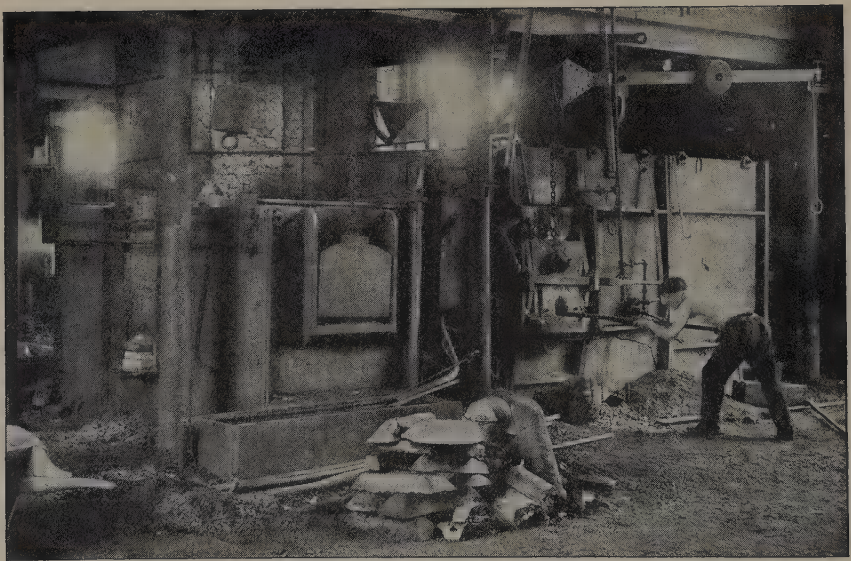
490 Remains of a Trip Hammer used at Hecla Furnace, Milesburg, Pa., about 1830, from a photograph by John H. McCoy, Milesburg, courtesy of Richard Peters, Jr.

PUDDLING PROCESSES

AFTER the introduction of blast furnaces pig iron was taken to a puddling furnace for further manipulation to fit it for commercial uses. There it was partially or wholly remelted and stirred (puddled) to purify it. It was eventually removed and hammered to purify it still further. If the hammering made it too hard for the purpose intended it was reheated to soften it. Just as pig iron was the name applied to either the liquid or solid product of the blast furnace, so the compact ball produced in a puddling furnace was called a "bloom." The trip hammer acted on the bloom in order to complete the work of purification started in the puddling furnace.

The trip hammer at Milesburg (No. 490), which has been long out of use, is propped up to indicate the way in which it was used. Raised by the turning of the wheel, it was then allowed to fall on the bloom placed on the anvil. Motion was given to the entire apparatus by a water wheel. A grooved roll through which the puddled iron was run squeezed impurities from it and might be substituted for the hammering process. Iron made in this way was called wrought iron and was for years the kind of iron employed wherever tenacity and strength were required. Where these qualities were unnecessary the iron as it came from the furnace or cupola was poured into suitable molds, and the article made was said to be of cast-iron.

Cast-iron, having fewer manipulations than wrought iron, was cheaper. But it was brittle and easily chipped or broken; hence, wherever these qualities were undesirable, wrought iron was prescribed.



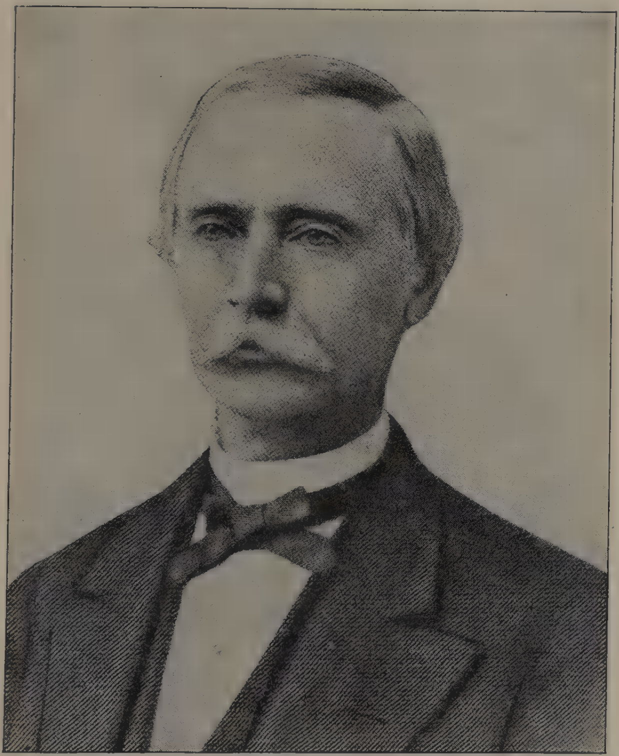
491 Stirring Iron in a Puddling Furnace, courtesy of the Bethlehem Steel Company

SIR HENRY BESSEMER, 1813–98, INVENTOR OF THE BESSEMER CONVERTER

THE national expansion that followed the Civil War not only called for more iron but cheaper iron. Steel was as well known to ironmakers as iron itself, but the only method of manufacturing it was slow, laborious and costly. The world needed abundant cheap steel. Sir Henry Bessemer, an Englishman, gave the world what it wanted; steel made in thirty minutes — not three months — steel little more expensive than iron, steel many times stronger than iron. Bessemer solved the riddle by pouring fifteen tons of molten pig iron into a movable pear-shaped vessel and then blowing hot air through the mass for about twenty minutes. The air combined with the carbon in the pig iron and passed out of the iron and the vessel in the form of flames. When all the carbon was gone a measured amount was restored to the iron. When the melted mass was poured into molds it was no longer iron but steel.

Cheap Bessemer steel revolutionized the iron-using industries. It replaced iron wherever great strength was an essential, or where resistance to excessive strain and wear was demanded. Thus it supplanted iron for rails, engine tires, bridge materials and for various kinds of tools or utensils.

492 From a photograph by Elliot and Fry, London



493 From J. G. Butler, *Fifty Years of Iron and Steel*, Cleveland, Ohio, 1918, courtesy of the Penton Press

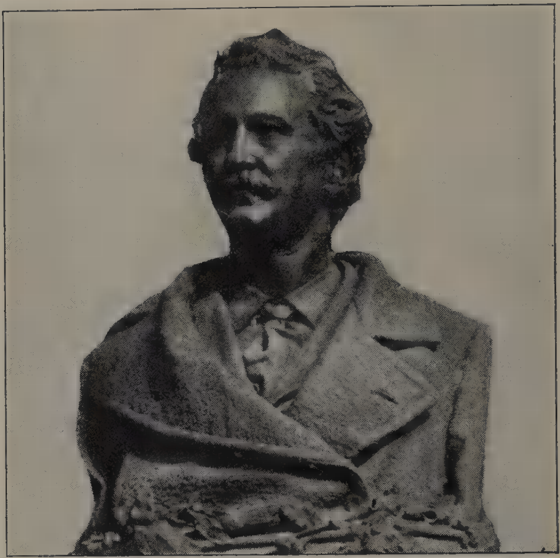
WILLIAM KELLY, 1811–88, AMERICAN INVENTOR OF THE BESSEMER PROCESS

BUT the United States had to wait five years before it could use the Bessemer converter; lawsuits stood in the path of progress. In 1856 when Bessemer tried to patent his process in the United States he found that William Kelly, an American, had independently hit upon the same idea and his claim to priority was sustained. Although Kelly obtained patent monopoly he never produced steel so successfully as Bessemer. On the other hand, the Kelly interests secured the patent rights to the Mushet process; that is, the process by which a known quantity of carbon is added to the blown iron in order to produce steel. Each blocking the other, Bessemer and Kelly at length saw the wisdom of consolidation, and in 1866 the two joined forces. In consequence America began a belated manufacture of the much sought steel. In a few years the age of steel had come to America. The first production of Bessemer-Kelly steel in America is generally conceded to have been at Troy, New York. This city at that time was as noted for its production of iron as it now is for the manufacture of collars.

494 Courtesy of the Bethlehem Steel Company

THE KELLY CONVERTER

To prove the value of his process Kelly built a converter at the works of the Cambria Iron Company. His first public exhibition before the employees of the company was marred by the fact that the workmen, as a joke, blew a tremendous blast of air into the converter of such strength as to shoot out the entire contents of the converter. A second experiment with a less vigorous blast was more successful. The original Kelly converter is now located at the Cambria plant of the Bethlehem Steel Company, Johnstown, Pennsylvania.



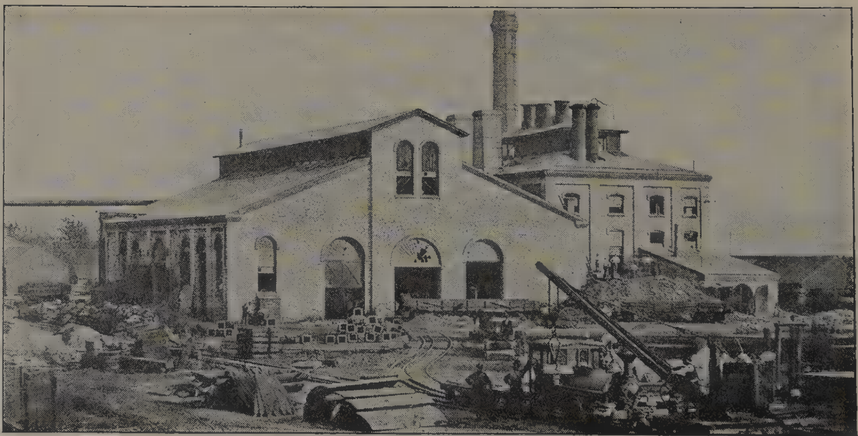
495 From the sculpture, 1889, by J. Q. A. Ward (1830–1910), in Washington Square, New York, courtesy of the Municipal Art Commission

ALEXANDER LYMAN HOLLEY, 1832–82, AMERICAN BESSEMER PIONEER

Alexander Lyman Holley is given credit for introducing the Bessemer process in America. Holley was born near Salisbury, the old and famous iron region of western Connecticut. His father was a governor of the state of Connecticut. Holley himself was a graduate of Brown University and at the age of eighteen had written an article on cutlery for *Poor's Railway Journal.* While still a student he had invented a cut-off for a steam engine. After graduation Holley became a practicing engineer and an author of works on engineering topics. In 1863 Corning, Winslow and Company of Troy, New York, sent Holley to England to learn the Bessemer process of steel manufacture. When he returned he had not only learned the process but brought with him the purchased rights to the American Bessemer patents. Holley set up the first American Bessemer plant at Troy, New York, and later made many improvements in the process. He also had charge of the erection of many other Bessemer works in this country, and was widely consulted as an authority. In 1890, eight years after his death, on the occasion of the convention in New York of the world's three greatest iron and steel associations, a monument to Holley was dedicated in Washington Square, New York.

HOLLEY'S SECOND BESSEMER PLANT

The second Bessemer plant erected by Holley was that of the Pennsylvania Steel Company, near Harrisburg, Pennsylvania. Here, in 1867, ingots were made which went into the first steel rails rolled in America. The rails were rolled by the Cambria Iron Company.



496 From a photograph, 1876, courtesy of Richard Peters, Jr.

A BESSEMER CONVERTER IN ACTION

To make steel by the Bessemer process, liquid pig iron is poured into the converter. Then hot air is blown through the mass. The carbon of the pig iron unites with the oxygen of the air and soars from the mouth of the converter in a hissing, spitting, sparkling flame. The color of the flame indicates when the process is finished. When the color has shown that the iron has been purified, materials with a known carbon content are thrown into the converter. The addition of this specified amount of carbon changes the iron into steel. The air is then shut off and the converter tilted so that the steel may be poured into a vessel called a ladle or directly into an ingot mold.

Among all the spectacular features of a steel mill that impress a visitor, there is none that surpasses a Bessemer converter when it is blowing. In comparison with it the most gorgeous Fourth of July fireworks are tame.

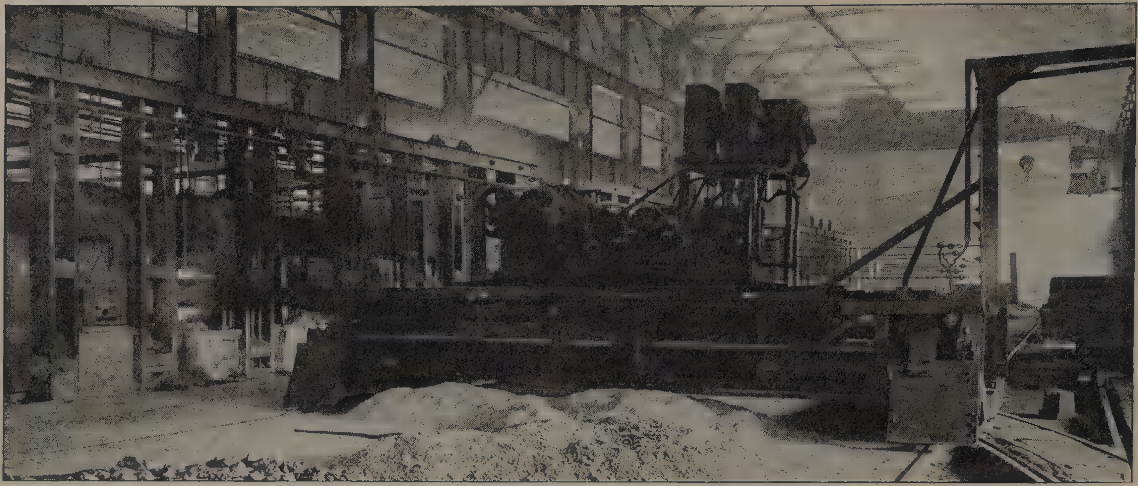
497 Courtesy of the Bethlehem Steel Company

498 Courtesy of the Brown Hoisting Machinery Company, Cleveland, Ohio

SCRAP STEEL FOR AN OPEN-HEARTH FURNACE

After twenty-five years' use of Bessemer steel the market again cried for a better material. A manufacturer could never guarantee the content of his Bessemer steel. Another process of steel manufacture called the open-hearth, in which steel is produced as a good cook makes soup, slowly and frequently tested, results in a steel that is absolutely guaranteed as to content. Although the process is slower and more expensive than the Bessemer, larger quantities of steel can be made at once, and the quality of it assured. By 1897 railroads began to turn to open-hearth steel and between 1899 and 1904 open-hearth output crept up and surpassed Bessemer. To-day the Bessemer process is largely preparatory for the open-hearth treatment. The use of both processes together somewhat shortens the time taken for making steel independently in the open-hearth furnaces.

The charge of an open-hearth furnace may consist of scrap steel, scrap iron, coke, limestone, melted pig iron or blown Bessemer steel. These are all (or combinations of them all) mixed together, "cooked," tested and corrected with the proper materials and eventually made ready for pouring.



499 Filling an Open-Hearth Furnace, courtesy of the Bethlehem Steel Company

MAKING OPEN-HEARTH STEEL

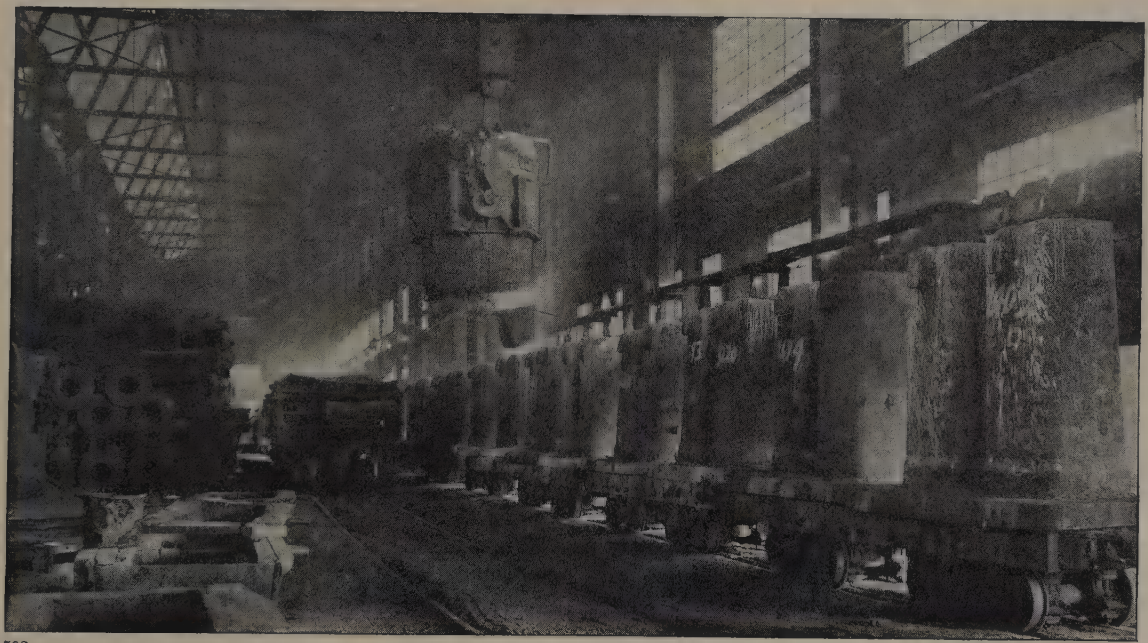
When the materials arrive they are put into the door of the furnace by an almost human machine. This "charging machine" can move itself along a track, push loaded cars full of charging materials wherever desired, lift the material into the furnace and empty it there. After the open-hearth furnace has finished its work, the liquid steel is poured out. The open-hearth furnaces are arranged in rows called "banks." The raw material which the charging machine feeds into the open-hearth is put in on one side of the furnace. The liquid stream of molten steel comes out on the other.

500 Pouring Side of a Bank of Open-Hearth Furnaces, courtesy of the Bethlehem Steel Company

501 Courtesy of the Bethlehem Steel Company

OPEN-HEARTH STEEL POURING OUT OF THE FURNACE

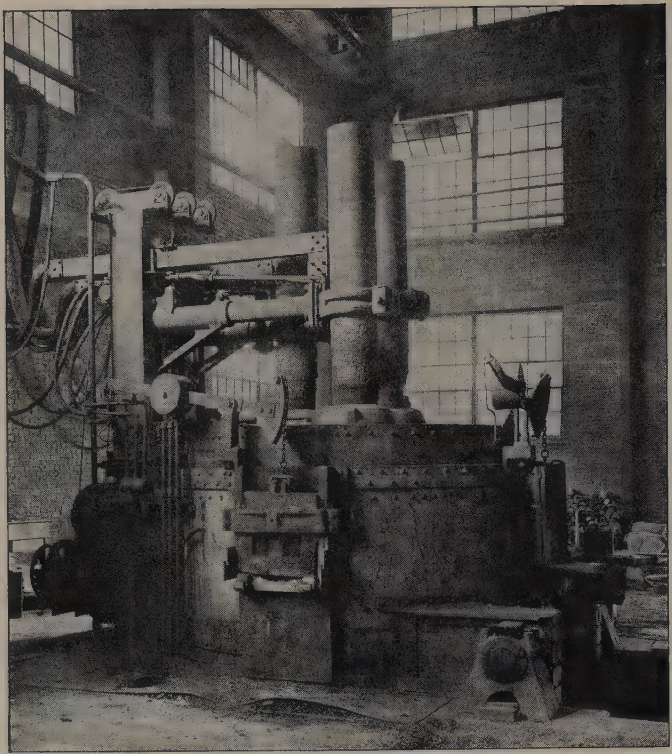
THE liquid steel pours out of the open-hearth furnace into a gigantic bucket called a "ladle." A smaller vessel alongside the ladle is provided to catch the overflow of slag, the liquid scum that floats on the surface of the steel. This slag was formerly dumped on to a waste pile but of late it is being put to use in the manufacture of Portland cement. Both the Bessemer and open-hearth processes produce liquid steel.



502 Courtesy of the Bethlehem Steel Company

FILLING INGOT MOLDS WITH LIQUID STEEL

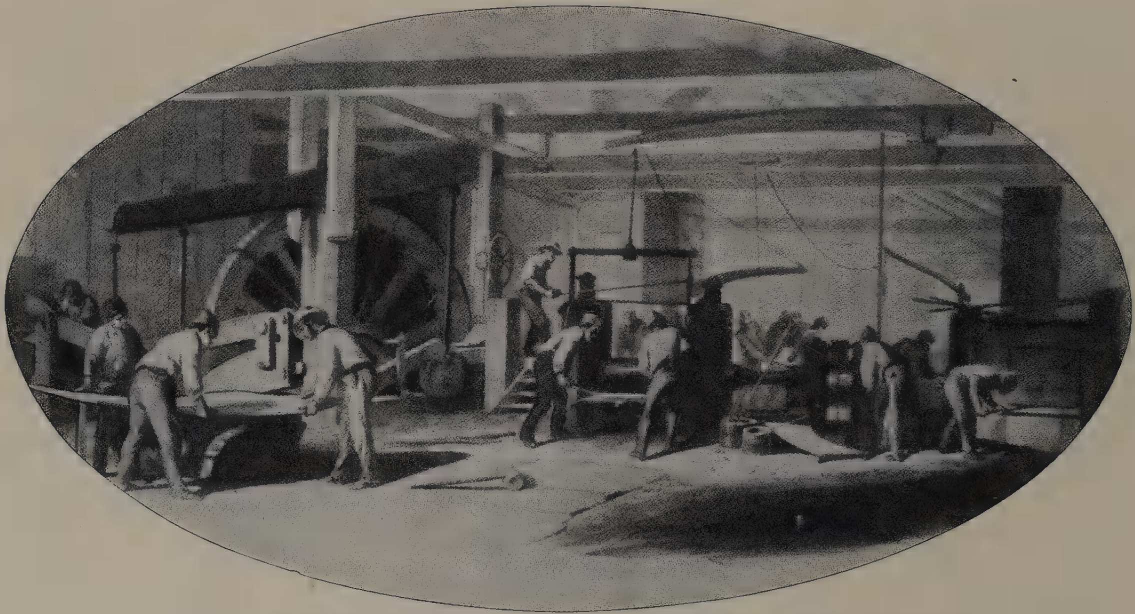
THE ladles filled with liquid steel are picked up by a crane and emptied into ingot molds set on cars. When all the molds are filled the cars are hauled into the air to cool. When sufficiently cool the ingot mold is stripped from the ingot as the skin is removed from a banana. The ingot is then ready for rolling after its heat has been equalized.



503 Courtesy of the Bethlehem Steel Company

THE ELECTRIC FURNACE

PROGRESS never ceases. Charcoal, anthracite and coke all in turn have played their part in iron production. To-day, men are again looking for a better smelter of ore. Experiments have been made with electric furnaces. These are simple and require fewer varieties of raw material than a regular blast furnace or steel furnace; but since their heat is derived from the resistance to an electric current of the material treated, the electricity must be produced cheaply at especially favored water-power sites, or gained as a by-product, in order to warrant the use of the furnace. Since electricity is as yet seldom cheaply produced, electric furnaces for smelting ore are not common. There are, however, many small electric furnaces for refining iron or steel previously made by the older styles of furnaces. The electricity is produced as a by-product of the older furnace operation.



504 From a drawing by the American Bank Note Company for the Lukens Steel Company, Coatesville, Pa.

AN AMERICAN ROLLING MILL, *ca.* 1820

ROLLING is a finishing process which produces such articles as rails, bridges, and structural forms. Before the day of steel, iron was run through the rolls by hand, a heavy, hot, and dangerous job. So many men were required to pass the metal back and forth through the rolls that the process was expensive. The mill at Coatesville, Pennsylvania, of the Lukens Iron Company was one of the earliest rolling mills in the country. Here, about 1820, boiler plates were first successfully made in America.

DRIVING WHEEL OF AN OLD ROLLING MILL

THE drive wheel of an old-fashioned rolling mill was attached by gears to a water wheel. The rolling mill in which this particular drive wheel functioned was attached to an old charcoal furnace at Milesburg, Pennsylvania, built about 1830. Its ruins were still in evidence until recently, recalling like so many remains in northeastern United States a stage of industrial advance that has long since been left behind.

A MODERN ROLLING MILL

MODERN rolls are driven by steam or gas engines or electric power. The passing of the metal is done by mechanical devices. Men seldom touch the metal itself but control all its movements by levers that operate portions of machinery. An old rolling mill presented a crowded appearance, but a modern one seems almost to run by itself without the intervention of human beings. The rolling mill has a curiously empty aspect, as though great machines alone were molding the steel to their will. Nowhere can be seen to better advantage the majesty of the iron man.

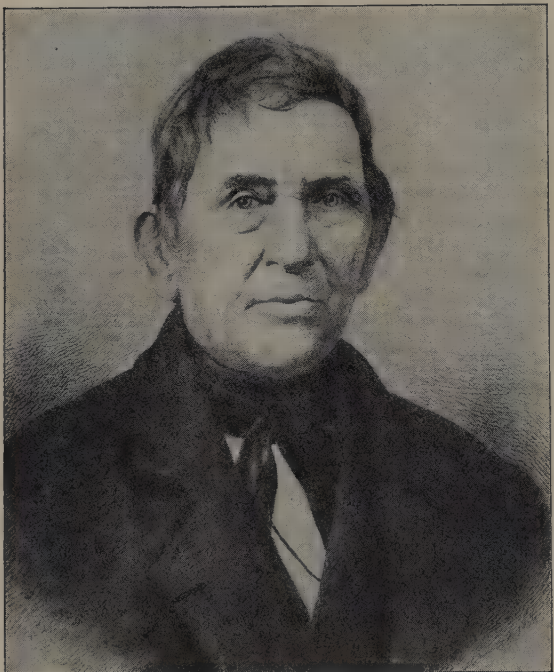
505 From a photograph taken at Milesburg, Pa., by John H. McCoy, courtesy of Richard Peters, Jr.

506 Courtesy of the Bethlehem Steel Company

507 Lifting Pots of Crucible Steel from the Furnace, courtesy of the Bethlehem Steel Company

THE MAKING OF CRUCIBLE STEEL

For articles requiring special or high grade steels, bar steel, one of the shapes produced by rolling, is cut up and put into small pots. Requisite materials are added and the mass is melted together at the proper temperature for the necessary length of time. The pots are then lifted from the fire pit and the mass is poured into forms. It takes a strong, active man to lift these heavy pots. He is wrapped in burlap and doused with water as a protection from the intense heat. This product is called crucible steel, and is generally manufactured in a plant removed from the main steel works.



508 From a crayon portrait, 1873, in the Public Library, Newark, N. J.

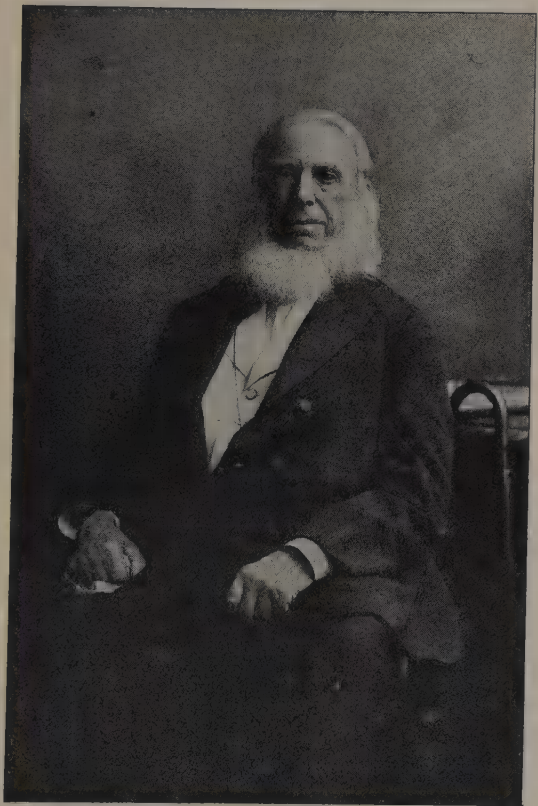
SETH BOYDEN, 1788–1870, AN EARLY PRODUCER OF MALLEABLE CASTINGS

To the development of the iron and steel industry "Yankee" genius has made its contribution. Born on a farm and trained to no trade, Seth Boyden at different times during his life was a watchmaker, a maker of silver-plated harness fittings, a manufacturer of patent leather, an ironmaster, a locomotive builder, a zinc refiner, and the propagator of an improved strawberry. Boyden was the first in America to produce malleable castings. Among his many inventions were a machine for making wrought iron nails, another for producing brads and tacks, a device for splitting leather, a hat former and improvements in harness manufacture. In Newark, New Jersey, where most of Boyden's life was spent, a bronze statue was erected to his memory in 1890, twenty years after his death.

REBECCA LUKENS, 1794–1854, A PENNSYLVANIA "IRONMASTER"

Among the most interesting of the early ironmasters was Rebecca W. Lukens. Mrs. Lukens was the daughter of Isaac Pennock, a Pennsylvania ironmaster who changed a sawmill into an iron mill which he called the Brandywine Mill, after the creek upon which it was located. Beside this same creek is the battle ground where General Washington fought unsuccessfully to save Philadelphia from falling into the hands of the British. Pennock left his property in the control of Dr. Charles Lukens, the husband of Rebecca, who ran the business successfully from 1816 until his early death in 1825. Mrs. Rebecca Lukens then assumed full charge of the works and conducted them with remarkable success for twenty-two years. During her managership boiler plate continued to be produced at the plant. After Mrs. Lukens' death the business fell to her son-in-law, Dr. Charles Huston, who in honor of Dr. and Mrs. Lukens changed the name from the Brandywine Rolling Mill to the Lukens Iron Company. The village created by the original mill has grown into the city of Coatesville, Pennsylvania, and other ironworks have been attracted there.

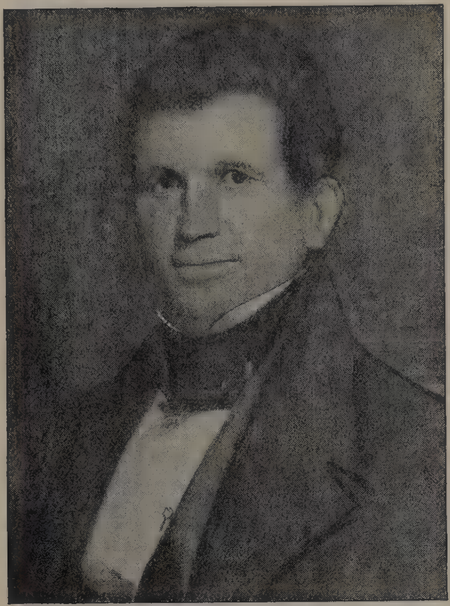
509 From the portrait, artist unknown, in the possession of Mrs. Preston Thomas, Coatesville, Pa.



510 From a photograph in the possession of the publishers

PETER COOPER, 1791–1881, A GREAT IRONMASTER

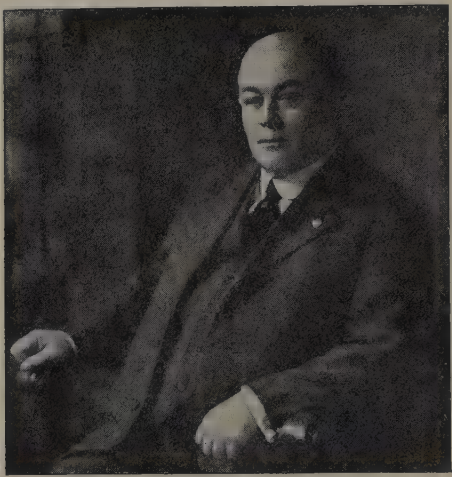
Peter Cooper, like Seth Boyden, was a man of many interests. Born in New York City in 1791, he learned his father's trade as a hat maker. But the father frequently changed his residence and trade and Peter gathered experience as a storekeeper, a brewer, and a brickmaker. Tired of his father's vagaries, he apprenticed himself to a coachmaker, and while working in that trade brought out his first invention, a device for mortising hubs. True to his father's blood, and also to the times, Cooper did not stick to coachmaking but tried himself as a grocer, a glue manufacturer, and an iron manufacturer. Although he prospered in all his ventures his fame rests on his success with iron. His first works were erected at Baltimore in 1828. Here he built the Tom Thumb locomotive for the Baltimore and Ohio Railroad, the first locomotive made and used on a railroad in the United States. Shortly afterward Cooper sold his Baltimore holdings and removed to Trenton, New Jersey. There he was engaged in iron manufacture for many years, and from this business acquired the fortune that enabled him to endow Cooper Union in New York; to aid Cyrus Field in laying the Atlantic Cable; and to run for the presidency of the United States.



511 From a portrait in the possession of Henry Burden, New York

HENRY BURDEN, 1791–1871, INVENTOR AND MANUFACTURER

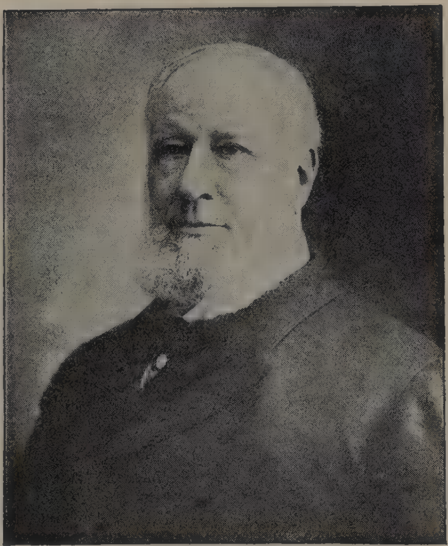
Henry Burden, a contemporary of Boyden and Cooper, was born in Scotland and educated at Glasgow University. As a youngster he invented a threshing machine and a gristmill for his farmer father. Coming to America in 1819, he was encouraged to engage in the manufacture of agricultural tools at Albany. While at this work he invented an improved plow and a cultivator. In 1822 he went to Troy as superintendent of the Troy Iron and Nail Factory. Here he served as man and master for the remainder of his life. Among his inventions was a machine for making horseshoes, another for the production of railroad spikes, and a third for squeezing iron. A spectacular feature of his ironworks at Troy was an enormous overshot water wheel sixty feet in diameter and twenty-two feet wide.



512 Courtesy of the Wellman-Seaver-Morgan Company, Cleveland, Ohio

SAMUEL T. WELLMAN, 1847–1919, PIONEER OF THE OPEN-HEARTH FURNACE

Samuel T. Wellman, although born in Wareham, Massachusetts, was brought up in New Hampshire, his father being a worker and later an official in an ironworks at Nashua. Wellman, after an apprenticeship in the mill and at the drawing board, first attracted attention by building and installing for Richard Potts and Loring in Pittsburgh, the first Siemens gas regenerative heating furnace in operation in the United States. Following this success, Wellman in 1870 built for the Bay State Iron Company, Boston, the earliest open-hearth steel furnace in America. With this habit of doing things first, Wellman again, in 1886, for the Otis Iron and Steel Company of Cleveland, built the first basic steel furnace in this country. In 1894 the Wellman-Seaver Engineering Company was formed. This company under Wellman's presidency was a pioneer in the development of handling apparatus for steel mills. Among them were the Wellman hydraulic crane, and the Wellman open-hearth charging machine. The latter (No. 499) is a truly marvelous contrivance.

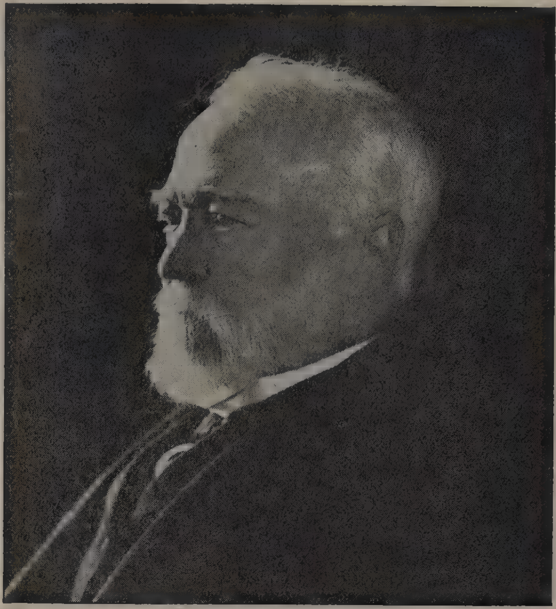


513 © Davis & Sanford, New York

BENJAMIN F. JONES, 1824–1903, PITTSBURGH MANUFACTURER

Benjamin F. Jones, born in 1824, was one of the pioneer iron manufacturers of the Pittsburgh district. His first partnership in iron was Jones, Lauth & Company, but this was soon dissolved and the famous Jones, Laughlin & Company started. This company built the Eliza furnaces in 1861 and was the first to use Connellsville coke in Allegheny county. Although the form of the business organization has been changed from Jones, Laughlin & Company first to Jones and Laughlin Company, Ltd., and later to Jones & Laughlin Steel Corporation, the names of the founders have always been retained in the business title because the originators were responsible for the great success, fame and goodwill which this business has built for itself during the many years since its inauguration.

ANDREW CARNEGIE, 1835–1919, STEEL MAGNATE



514 © Underwood & Underwood

The name most popularly associated with the iron and steel industry is that of Andrew Carnegie. Yet Carnegie's early life seemed more likely to make him famous as a railroad man rather than an ironmaster. Emigrating to America with his father from Scotland, Carnegie followed his father into a cotton mill at Allegheny City where the youthful Andrew became a bobbin boy. Showing aptitude for mechanics, he was put at thirteen in charge of the engine in a small bobbin factory. But when his employer learned that the boy could read, write and cipher, Carnegie was transferred to a clerk's position in the office. Seeing no opportunity in this job Carnegie became first a messenger and then an operator for the Ohio Telegraph Company at Pittsburgh. In this position he attracted the attention of Thomas A. Scott of the Pennsylvania Railroad, who took Carnegie into his own office as a clerk. When the Pennsylvania installed telegraphic train dispatching Carnegie, as its originator, was put in charge of the lines. When Scott advanced to the presidency of the Pennsylvania, Carnegie was moved into Scott's former position as superintendent of the Western Division. During the Civil War, Scott took Carnegie to Washington with him to operate military trains and government telegraphs.

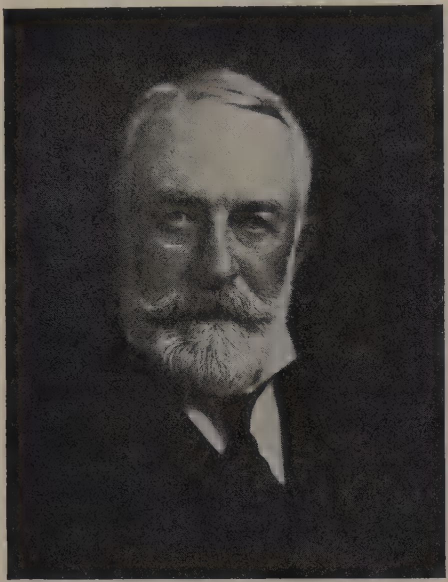
Following the war Carnegie was impressed with the future prospects for iron railroad bridges and organized the Keystone Bridge Company to manufacture bridge materials for the railroads, including the Pennsylvania. The success of this venture led Carnegie deeper into the iron industry, first with rolling mill properties, then blast furnaces, steel mills and eventually all the iron and steel interests that became identified with his name.

Carnegie was never a practical iron and steel man, that is, a technician. He was an able captain of industry and an organizer with a marvelous gift in picking the proper technicians for associates. While Carnegie was shrewd, his advances were always made cautiously. On several occasions he was carried into new ventures by his associates against his own wishes, the very ventures that harvested for him golden rewards. Carnegie's business success culminating in his openhanded philanthropy made his career doubly remarkable.

515 From the crayon portrait in the possession of the Carnegie Steel Company, Pittsburgh

CAPTAIN "BILL" JONES, 1839–89, ONE OF CARNEGIE'S "FINDS"

One of the most interesting figures of the Pittsburgh iron industry was Captain William R. Jones, known as "Bill" Jones. Born in 1839 of poor Welsh parents at Catasauqua, Pennsylvania, where David Thomas was making his experiments with anthracite, Bill obtained his first job, at the age of ten, in the works of Thomas. Andrew Carnegie, with his genius for discovering the right man, put Jones in charge of his Braddock works in 1873. Setting the pace for the other manufacturers, he soon surpassed them all in quantity of production. With a dash of recklessness and considerable driving power in his make-up Jones was able to win the devotion of his workmen and assistants. He was one of those dauntless workers who did much to bring to the United States supremacy in steel. Jones died on the job, September 28, 1889, in an explosion at his works.



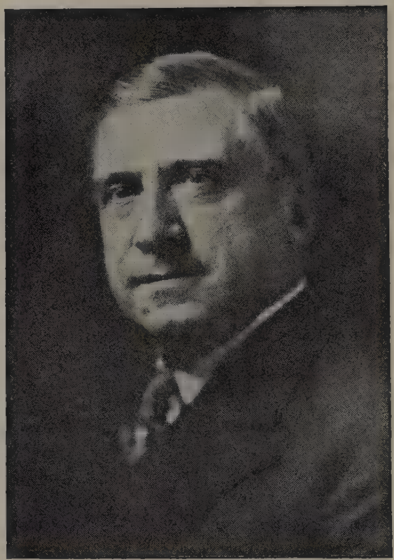
516 © Pach Brothers, New York

HENRY CLAY FRICK, 1849–1919, MASTER OF COKE

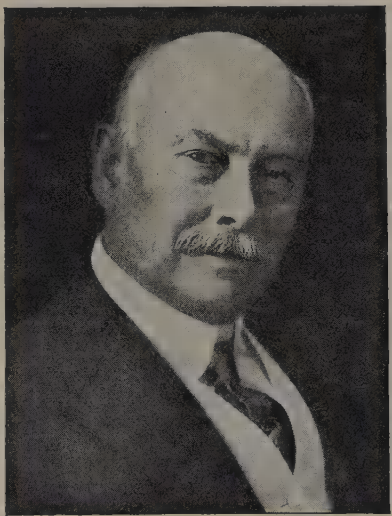
Henry Clay Frick will always be named among great steel men although much of his life was given to the manufacture of coke. Frick was born in Pennsylvania in 1849 and attended Oberlin College in Ohio. His first job was as a clerk in a dry goods store at Mount Pleasant, from which he was transferred to Broad Ford to become a bookkeeper. While in this position, struck with the possibilities of the coking coal in the neighborhood, he began to buy or lease coal lands. In 1871 the firm of H. C. Frick & Company undertook the manufacture of coke. The panic of 1873 was his opportunity to consolidate and expand his holdings. Eventually Frick dominated the coke industry. His ability attracted the Carnegie interests, and in 1889 Frick became general manager for the Carnegie properties, meanwhile retaining control of his own. In 1900 the Frick and Carnegie interests were merged in the Carnegie Company, which succeeded the Carnegie Steel Company, Ltd. Frick thus became one of the principal beneficiaries after Carnegie himself when the Carnegie Company sold out to the United States Steel Corporation. It is said that Frick was the only man ever associated with Carnegie whom the latter could not dominate.

CHARLES M. SCHWAB, 1862–

Charles M. Schwab has had a career of the sort called typically American. From the lowly job of stake driver in the engineering corps of the Edgar Thompson Steel Works, he rose to the presidency of the largest steel corporation in the world. Schwab was one of the favorite "young partners" of Carnegie, and held many positions of importance and trust under Carnegie, including the presidency of the Carnegie Steel Company, Ltd. Schwab, who is credited with being the greatest salesman in America, is supposed to have given the idea of the United States Steel Corporation to the men who afterward created it. Schwab himself was president of that corporation for three years. In 1925, he was chairman of the board of directors of the Bethlehem Steel Corporation and the Bethlehem Steel Company. During the World War Schwab acted for a time as the Director General of shipbuilding for the United States Shipping Board Emergency Fleet Corporation. Like other steel magnates Schwab has been noted for his benefactions.



517 From a photograph by Pirie MacDonald, New York



518 From a photograph, courtesy of Mr. Gary

ELBERT H. GARY, 1846–,

Elbert H. Gary, chairman of the United States Steel Corporation, was trained as a lawyer and practiced in Chicago for twenty-five years, and at one time was president of the Chicago Bar Association. He became interested in the formation of the Federal Steel Company, of which he was the first president. His new duties caused his retirement from the practice of law. When the United States Steel Corporation was planned, Gary had a prominent part in its organization and was made chairman of its board of directors as well as chairman of its finance committee. Mr. Gary became president of the American Iron and Steel Institute.

A STEELWORKER FROM ITALY

In portraying some of the men who have made American iron and steel lead the world, the men on the job should not be overlooked. Officers alone do not constitute the army; neither do the officials in industry solely determine the industry's success. The steel industry owes a heavy debt to the brawn and brain of our immigrant stocks. It has been the sweat and the ideas of these men that have been wrought into metal produced in record amounts, at record speed and with record efficiency. The photograph of an Italian steelworker in an American mill (No. 519) is included in our series to indicate the debt of American steelmasters to the Latin type of labor. Not only Italians, but often Roumanians, occasionally Spaniards and, rarely, Frenchmen are found as "midwives" attending the labor of furnaces in the birth of iron and steel.

519 From a photograph by Lewis W. Hine

520 From a photograph by Lewis W. Hine

A GERMAN STEELWORKER

The men of the steel industry are of many nationalities, of many degrees of strength and skill; but the fierce heats, the inexorable demands for the utmost efforts, the unending service demanded by the insatiable monsters they wait upon, the constant threat of sudden, awful death, weld these men of diverse origins into a unified, coördinated, purposeful group, a band of pygmies that by unity control titans.

Here the Latin and the Teuton work shoulder to shoulder, forgetful for a time of their inherited antipathy, joined together in a common cause to conquer resisting metal.

SLAV STEELWORKERS

Slavs, too, drawn from all peoples from the White Sea to the Black, from the Arctic to the Mediterranean and Caspian, bend their backs and strain their muscles in the service of American steel.

521 Slovaks going to Work, Pittsburgh, from a photograph by Lewis W. Hine

522 A Polish Steel Worker, from a photograph by Lewis W. Hine

523 A Group of Russians, from a photograh by Lewis W. Hine

524 A Group of American Steelworkers, from a photograph by Lewis W. Hine

NATIVE AMERICAN STEELWORKERS

The American, who is a composite of Latin, Teuton, Slav, Anglo-Saxon and Celt, does his share with his brother workers at the blast furnace, converter, open-hearth and rolls. He is the product of the mingled blood of former immigrants; his counterpart of to-morrow will include in his heritage that of the "foreigner" of to-day.

A STEELWORKER FROM ENGLAND

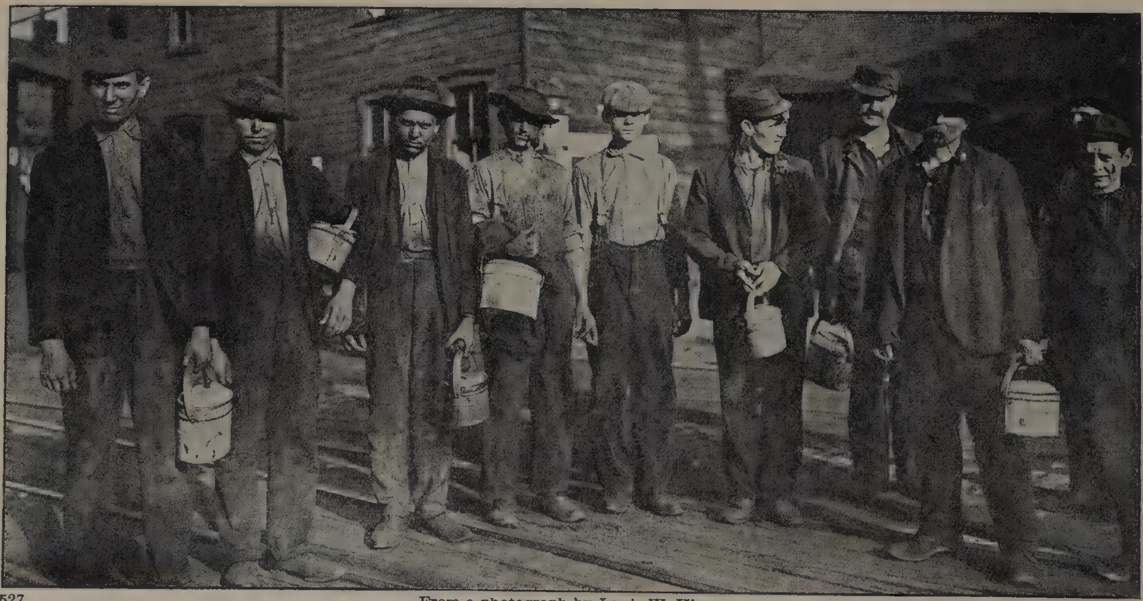
English, Scotch, Welsh and Irish are to be found in considerable numbers in Pittsburgh, Youngstown, Buffalo, Duluth or wherever American iron is made.

525 From a photograph by Lewis W. Hine

THE MELTING POT OF THE STEEL INDUSTRY

This photograph of a chance group of steelworkers exemplifies the wide range of nationalities employed in this industry. Slovaks, Americans, Irish, Germans, and Poles are represented, besides several individuals of indeterminable origin.

526 An American at Homestead, Pa., from a photograph by Lewis W. Hine



527 From a photograph by Lewis W. Hine

528 From the mural by Edwin A. Abbey (1852–1911), in the dome of the state capitol, Harrisburg, Pa. © Curtis & Cameron

THE SPIRIT OF VULCAN

The making of iron and steel, the erection of steel frame buildings or bridges, the quarrying of stone, the delving for minerals in the bowels of the earth, the hewing of forests — all these appeal to the imagination and contain elements of the picturesque. Crafts calling for deftness, speed, or precision likewise have their charm for the seeing eye. No industry furnishes so attractive a subject to the artist as the making of iron and steel.

THE IRONWORKER

Strength with grace, force with ease, determination with acceptance of leadership, all attributes of an ironworker, are fittingly cast in this enduring bronze statue planted before the home of an ironmaster.

529 From the painting by Gerrit A. Beneker (1882–) in the mills of the Hydraulic Steel Company, Cleveland, Ohio

THE TEST

Not only in plaster, stone, and bronze, but with pencil and brush have artists depicted the ironworker. The brilliant spitting light of the tested steel, the clustering shadows of the furnace room, the heat of the place and process, the intelligence and persistence of the men — these have caught the artist's eye.

530 From the bronze statue by J. L. Gérôme (1824–1904) in front of the residence of Charles M. Schwab, New York

WELDING

This is a picture of contrasts and struggle, light with shade, man against metal, mind matched with matter; an epitome of life itself. Man faces nature in a multitude of aspects. Perhaps better than any other the story of steel symbolizes his relation to the material world. He can create nothing. He can merely take the raw metal from its resting place and learn by diligent study its composition. Only by adjusting himself to the peculiarities which he has discovered can he shape the metal into the objects which will be of use to him.

531 From the painting by Gerrit A. Beneker in the mills of the Hydraulic Steel Company, Cleveland, Ohio

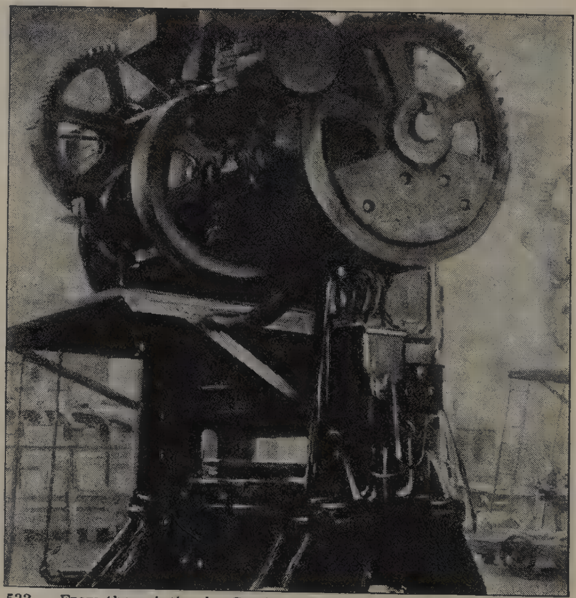
532 From the painting by Gerrit A. Beneker in the mills of the Hydraulic Steel Company, Cleveland, Ohio

MEN ARE SQUARE

Beauty may be expressed in curves, but character produces and is portrayed in straight lines. The men of steel are square of brow, of chin, of shoulder. The outward form indicates the inward spirit. The work which shapes the body molds the character, for steel cannot be made by trickery. Like the pioneers who attacked the forest these men who work with iron and steel are dealing with nature, naked and untamed.

THE IRON MAN

Man, however stalwart, is a puny thing, but what he lacks in muscle he makes up in mind. With his intelligence he makes the huge mechanical monsters that bend and shape materials that he alone could not budge. A gigantic machine, like the ones seen in a steel mill, is not only a triumph of mechanism, but a marvel of the capacity of the human mind to shape the forces of nature to its ends. Looking at one of these great machines and remembering that science is still young, one wonders what marvels will become the commonplaces of life among future generations.



533 From the painting by Gerrit A. Beneker in the mills of the Hydraulic Steel Company, Cleveland, Ohio

CHAPTER X

LOGGING AND LUMBERING

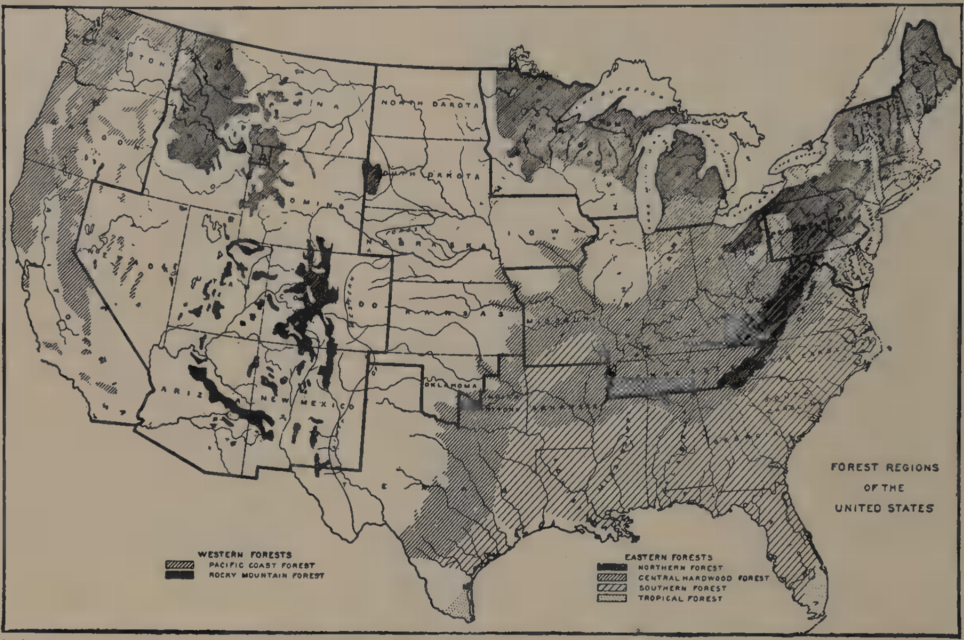
THE early colonists who came to America found much of the continent covered with forest. This forest must be cleared away before agriculture was possible to any extent. Since farming promptly became the most important source of food supply, the edge of the forest retreated westward as the pioneer farmers cleared more and more land. With the coming of more settlers and the natural growth of population the cutting of the forest was increased. Not only were the trees felled to get them out of the way, but wood became a most important building material. Eighteenth and early nineteenth-century American cities were built largely of wood. The old merchant marine of the days before the Civil War was composed of wooden ships. Wood supplied most of the needs of a rapidly growing population for furniture and for vehicles. The place of iron and steel in modern life was to a certain extent taken by wood for more than two centuries of American history.

Nor has the need for wood passed. Wood is still an indispensable building material. Incredible as it may seem to some people, wood is to this day one of the most important domestic fuels. With the growth of population the demand for wooden articles of many kinds has increased. The need for cleared land and that for wood manufactured into many forms has resulted in the sad depletion of the nation's forests.

In America the rate of cutting has proceeded three or four times as fast as the rate of growth with the result that the most productive forests in one period are not those to which the industry looks for its principal supply at a later time. But no forest region has yet been cut completely and abandoned. The first forest area to be exploited was that of New England. This was followed in turn by the forests of New York, Pennsylvania and the Lake states. Later, within our own time, the center of the logging industry has been in the South, both in the Atlantic states and also those near the Gulf of Mexico. The latest cutting regions have been in the Rocky Mountains and upon the Pacific coast.

Logging is the trade term applied to the business of getting trees to the sawmill. It includes the felling of trees, the cutting of trunks into logs, and the transportation of logs from the place where the trees are felled to the mills where the logs are sawed into lumber. Although most logging is concerned with converting timber into lumber, there is some logging conducted with the primary purpose of collecting certain valuable barks. The stripped logs may or may not be "logged" afterwards for lumber. Likewise there has been at various times some logging incidental to the gathering of turpentine and other "naval stores." Similarly the term logging has been applied to forest operations that were conducted for the purpose of getting out cordwood for domestic fuel or for hewing railroad ties or mine timbers.

Due to differences in the kinds of trees felled and to the topography and climate of the forest areas each forest region has developed certain peculiar methods of logging.



534 Courtesy of the United States Forest Service

THE EXTENT OF AMERICAN FORESTS

Before white men began the exploitation of continental America there were some eight hundred and twenty-two million acres of forest land to be had for the taking, a forest stand that constituted the most magnificent commercial timber resource of the world. Although over two thirds of this original forest has disappeared there are about one hundred and thirty-seven million acres of virgin forest and four hundred and sixty-three million acres of tree-covered land still available. In quantity of useful forest the United States is unsurpassed.

These tracts are classified in great forest areas. From the map it may be seen that these areas are northern, central hardwood, southern, tropic, Rocky Mountain and Pacific coast forests.

NEW ENGLAND LOGGING

Logging began in New England as early as 1623 and has continued to the present time. Until about 1870 the principal tree cut was the white pine, the best all-purpose wood ever known in America. By 1870 "primeval pine" was for the most part cut out and thereafter the white pine that has been felled has been mostly second growth. After 1880 it was discovered that wood pulp could be used to manufacture paper. For this purpose hemlock, spruce and poplar, large trees or small, could be used. This pulp wood logging gave a new impetus to New England's dying forest operations and caused the cut to increase year by year up to 1907 when it reached its maximum. At the present rate of exhaustion it is estimated that New England soon will supply less than half of its own wood needs, and within a score of years, all its timber will be gone except that in farmers' wood lots, a few stands of second growth and the relatively small forests contained in the White Mountain national forest and state forests. Meanwhile the center of logging passed westward and as early as 1850 half of the cut for the nation was outside of New England.

535 White Pine, New Hampshire, from a photograph by the United States Forest Service

536 Second Growth Pine, Michigan, from a photograph by the United States Forest Service

LOGGING IN THE NORTH CENTRAL STATES

From New England to Wisconsin by way of New York and Pennsylvania there was once almost continuous forest, virtually uniform throughout this area, with the white pine the chief tree. Here the methods of logging were everywhere similar. As the cut declined in New England, New York produced the greatest volume in 1840, and Pennsylvania in 1860. Ten years later Michigan was the banner state in amount of logs cut, but was forced to yield to Wisconsin in 1900. All this region is still cutting timber into logs, but the history of New England has been repeated in that the white pine has virtually disappeared and the cut now is confined to other trees, many of which are destined for pulp. By 1900 the nation had begun to turn to southern forests for most of its lumber.

537 Old-time Bunk House, Maine, from *Harper's Weekly*, Sept. 25, 1858

THE WINTER LUMBER CAMP

In New England, New York, Pennsylvania and the Lake states logging has generally been a winter job, partly because much of the capital and labor came from among farmers, who used logging as an off-season occupation, and partly because the northwoodsmen had to rely upon nature's aid for transportation. Snow-covered ground and frozen swamps, lakes, rivers and brooks made it easy to transport enormous loads of logs, whereas the forest floor in summer was impassable except at great expense. Furthermore spring floods were used to float logs from the cutting area to the sawmills; this feature made it imperative to do the felling in the winter in advance of the spring freshets.

From 1623 to the present time the first essential of logging was a camp located centrally to the cutting area. This camp was composed of rude buildings constructed in the late summer before the regular crews went into the forests. The camp was made up of bunk houses for the men, a mess house or cook house, shelters for animals and a store for warehousing supplies and furnishing the men with simple necessities. The logging camps looked much alike. The houses were constructed of logs and the gaps filled with mud or snow to keep out the cold. One of the features of the early camps was the use of oxen for traction. In the modern camps the horse has replaced the ox.

The houses and furnishings of a lumber camp were rough but not uncomfortable. They fitted their environment, the use for which they were intended, and the life of the backwoodsmen who occupied them.

538 A Modern Winter Camp, from a photograph by the United States Forest Service

539 From *Harper's Weekly*, Feb. 4, 1888

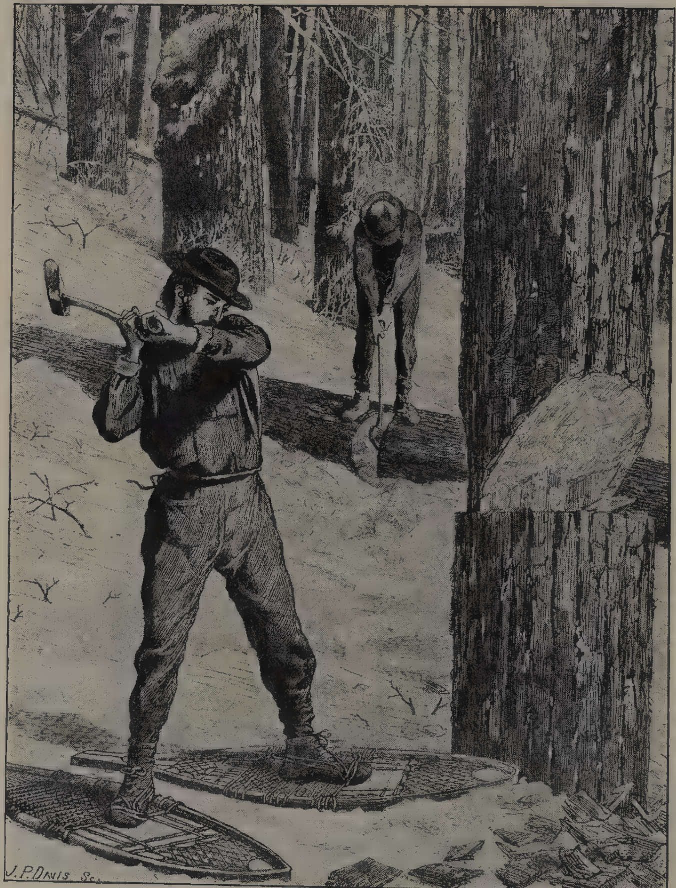
THE MESS HOUSE

THE food was simple but abundant. Men who worked out of doors all winter had excellent appetites, and their food was hearty in character rather than dainty. Table etiquette matched the food. The lumber jack has long been one of the picturesque figures of the American forest.

FELLING TREES

WITH the opening of winter the logging crews entered the camp to begin the season's work. The first job was the clearing of roadways. These radiated throughout the cutting area and led to the bank of the streams selected to float the logs in the coming spring. When the roads were ready and the snow had begun to fall the cutting of trees began.

This work was subdivided. An expert axman felled the trees, and so exact was his work that he could set a stake or other marker in the ground and hit it with the tree when the latter crashed to earth. An experienced man could cut a large tree within an hour's time. When the tree was on the ground less experienced men lopped off the branches and cut the trunk into logs of uniform length.



540 From *Every Saturday*, Jan. 28, 1871, after a drawing by Winslow Homer (1836–1910)

THE HAUL TO THE RIVER

When the logs were ready a teamster hauled them to the river bank. Sometimes this was done in two operations. First the logs were pulled along the ground — "snaked" — to the nearest roadway, where they were piled together. Second, these roadside piles — skids — were loaded on to sleds and driven to the river bank where they were piled once more within reach of the forthcoming spring-flood waters.

541 From *Harper's Weekly*, Sept. 25, 1858

The motive power for the transportation was at first always oxen, and these even now may be seen in service, although they have been generally supplanted by horses. The change from oxen to horses was hailed as a remarkable advance because so much time and labor were saved. Of late, "snaking" may be done by steam engines and cables, and haulage by tractors; but these devices are rare in New England and Lake state forests.

542 Hauling a Mountain of Logs, from a photograph by the United States Forest Service

THE END OF THE HAUL

Before snow fell a logger roadway bore but slight resemblance to a road, for hollows were filled crudely with small trees and brush, and elevations were but slightly cut down. But snow transformed it into an effective traction surface, smooth with banked curves and the ruts iced. On these roads sleds slipped so easily that a few animals could move gigantic burdens without undue effort. The largest load of logs ever hauled on sleds by horses contained fifty thousand five hundred and eighty board feet and weighed two hundred and fifty tons. It would fill nine railroad flat cars with logs. Six horses pulled the load fifteen miles.

543 Logs on a River Bank, from a photograph by the United States Forest Service

544 From a photograph by the United States Forest Service

A LOG BOOM

WITH the break-up of winter and the thawing of river ice and the rising of spring floods, the New England and Lake state lumber camps ceased cutting. Many of the men were paid off, and the teams went home before the ice was off the swamps.

The youngest, most vigorous, alert, hardy, and daring men then began the "river drive." They pushed the piles of logs into the raging freshets until the whole river from bank to bank was one mass of plunging, rearing logs, careening madly down the flood. It was the river crew's job to follow the logs and see that nothing stopped their progress. Stranded logs were shoved back into the current, and jammed logs were set loose. Since no boat could live when buffeted alike by racing current and upending logs, the river men had to ride the logs themselves, aided by their spiked shoes and balanced by their pike poles. No circus rider showed greater skill. A slip or misjudged step meant death by drowning or crushing between logs. The banks of New England rivers are marked by the graves of river men, for few log drives go through without the sacrifice of human life.

A LOG JAM

LOG jams were most likely to occur at rapids, below falls, at narrow gorges or at bends. If a log caught, hundreds piled up in a few minutes. Then the river men risked their lives to pry loose the key log, the one that held the mass. If prying failed, the log was hacked into pieces or blown up with dynamite. A jam might be cleared in a few minutes or, if there were more than one key log, it might take hours or even days to get the mass in motion. In any case a jam always meant feverish work and tremendous risk. Jam-breaking was the principal hazard in river driving.

The graves along the banks of streams bear mute witness to the failure of log drivers to move quickly enough when a log jam was broken.

545 A Jam on a Wisconsin River, from *Harper's Weekly*, June 5, 1869, after a photograph by N. A. Preston

546 From a photograph by the United States Forest Service

LOGS STRANDED IN SHALLOW WATERS

Logs went downstream on the crest of the spring flood. A stream grown shallow with the advancing season could not carry the burden of logs. In such case the difficulties and expense made it unprofitable to continue the drive. Sometimes a whole winter's output would be abandoned and lost. Although tools and equipment have been improved in efficiency, the basic methods of logging have changed but little with the passing years.

547 From a photograph by the United States Forest Service

SORTING LOGS AT THE END OF DRIVE

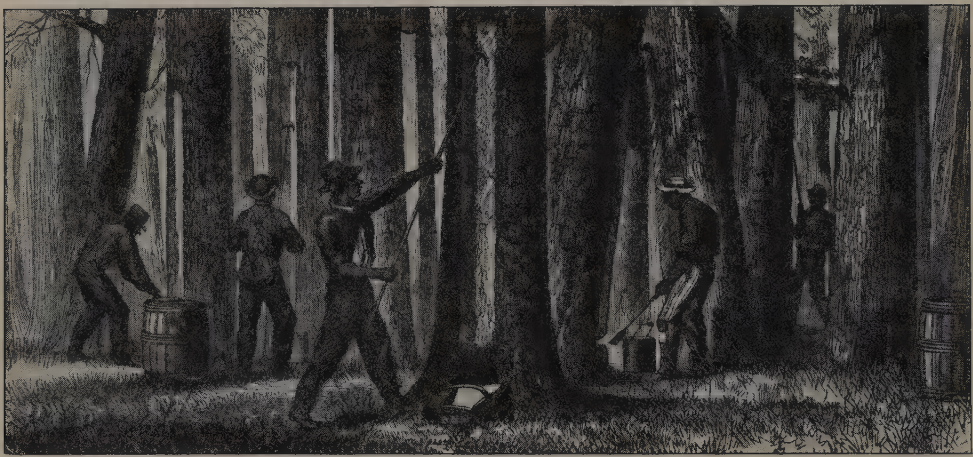
The end of the river journey was usually a quiet pond where the logs were sorted and put through the sawmill. On the end of every log a mark was cut indicating the company to which it belonged and the owner of each mill was supposed to select the logs destined for him as they passed through his pond. All other logs were allowed to pass the barriers and go down river to their various destinations. The river journey from forest to mill pond often took weeks and covered scores of miles.

548 A North Carolina Lumber Camp, from a photograph by the United States Forest Service

A SOUTHERN LUMBER CAMP

The forests of the South show several marked contrasts to those of the Northeast, and within the South itself there are differences between the forests of the Atlantic states and those bordering the Gulf.

The South Atlantic forest contains as its principal commercial tree the yellow pine. This is inferior to its cousin the white pine, but is better for most purposes than any other American commercial tree. The absence of snow in the South prohibited the use of sleds, and the presence of deep sand made horse-drawn wheel vehicles difficult although not impossible. A fairly level topography, however, led to the general use of logging railways. Since the railroad and the camp could be operated throughout the year, continuous use offset the higher costs. Furthermore, constant operation made it possible to construct camps more like small towns, where normal family life could be enjoyed.



549 From *Frank Leslie's Illustrated Newspaper*, Sept. 29, 1866

COLLECTING TURPENTINE, NORTH CAROLINA, 1866

Before the South Atlantic forest was cut for logs and lumber the yellow pine had served chiefly as a source of turpentine, rosin and tar. This business began in North Carolina and moved by decades down the coast to Florida, and eventually over into the lower Mississippi valley. This migration was caused by the gradual exhaustion of the tree supply in the older regions.

To collect the sap small cavities were cut in the bottom of the tree; from two to four, depending on its size. At intervals of a few days the bark above the gouge was cut away until the cut was beyond a man's reach. The sap ran in the gouge and was collected in buckets and barrels at regular intervals. The period of collection extended from January to September. The next year the same trees were gouged above the gouges of the previous year. Of course this process in time killed the trees. Sometimes the trees were cut down at the start and the sap distilled from the wood.

550 From *Frank Leslie's Illustrated Newspaper*, Sept. 29, 1866

AN OLD-TIME TURPENTINE DISTILLERY AT WILMINGTON

The pine sap collected from the trees was taken to a distillery. By a process of boiling, steam was drawn off from the sap which when condensed was turpentine, ready to be barreled and sold. The residue was rosin or tar, which was also sold. The turpentine industry still continues in some places in competition with logging, in others in conjunction with logging companies. Both industries are destructive and continue only by exploiting new areas.

SOUTHERN LOGGING IN THE 'SIXTIES

Before the Civil War there was some logging and sawmilling in the South Atlantic region at such places as Wilmington, Georgetown, Savannah and Jacksonville, and at the mouth of a few navigable rivers. These enterprises skirted the edge of the forest. After the Civil War a number of ex-service men from the Union army pushed back into the forest, erected villages, set up crude sawmills and started the logging and lumber industries.

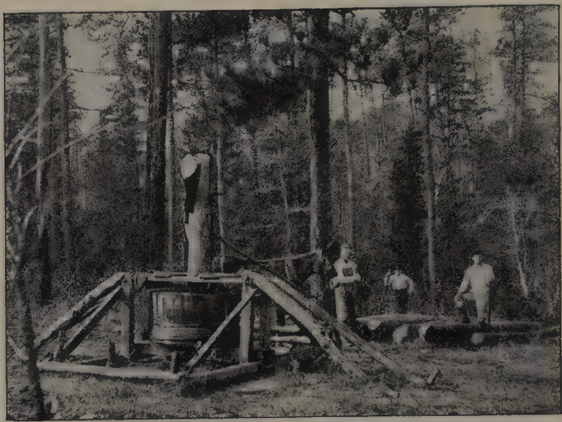
551 Hauling Logs, North Carolina, from *Frank Leslie's Illustrated Newspaper*, Aug. 10, 1867, after a sketch by James E. Taylor

552 A Yankee Sawmill and Settlement, North Carolina, from *Frank Leslie's Illustrated Newspaper*, Aug. 10, 1867, after a sketch by James E. Taylor

553 From a photograph by the United States Forest Service

SAWING SOUTHERN PINES

In the South, trees are often felled by sawing instead of chopping. Yellow pine trees are frequently boxed for turpentining before cutting. The absence of snow in the southern forests is in marked contrast to the familiar winter scene in the North.



554 "Snaking" Logs with Mule and Capstan, South Carolina, from a photograph by the United States Forest Service

TRANSPORTING SOUTHERN LOGS

Logs are "snaked" by animal traction or by small stationary steam engines to the line of railway where they are loaded on cars. The logging railway carries the logs to a sawmill or to the main line of a standard railway. The peculiar shape of the locomotive chimney (No. 555) is due to the fact that, like our first railways, the engine is a wood burner.

Since the logging railway operates upon a temporary right of way which must shift as the cutting area changes, no great engineering care is employed in laying the tracks. In many cases these are merely slender logs fastened to other logs used as sleepers. This method of transportation lacks some of the romance of the snow and ice roadways of the North, or the rushing spring torrents in the rivers.

555 Steam Derrick loading Logs on to a Railway Car, Louisiana, courtesy of the Great Southern Lumber Company, Bogalusa, La.

556 From a photograph by the United States Department of Agriculture

LOGS GOING TO THE SAWMILL, FLORIDA

WHERE the logging company does not operate a logging railroad, a high-wheeled gig is used for hauling logs to a sawmill by means of ox or mule traction.

557 From *Harper's Weekly*, June 14, 1873

TIMBER CUTTERS IN A SWAMP CAMP

PART of the Gulf forest lies on sand ridges sloping away from the Mississippi and other rivers. On these ridges the yellow pine is the principal tree and the logging camps and methods of transportation are analogous to those of the South Atlantic logging industry. But away from the rivers are great areas of swamps. Growing in the water of the swamps is the cypress tree, whose wood is so impervious to weather and decay that it is called "the wood eternal." On hummocks within the swamp is another valuable tree belonging to a group known as gum trees. These swamp forests call for methods different from those of dry land.

The swamp camp is a house boat. On these boats the loggers and their families live the year round, moving from one cutting area to another as occasion requires.

558 Cutting Gum Trees in a Swamp, from a photograph by the United States Forest Service

SWAMP LUMBERING

The swamp lumbermen cut their trees standing in water of varying depths, an arduous task in the humid, insect-ridden atmosphere, conditions with which few white men can successfully cope. Most of the swamp workers are colored or Mexicans.

At the cutting area in the swamp a number of canals are dug which radiate from a central point. In each of the radial canals is a small flatboat upon which a small stationary steam engine is mounted. Cables from this engine are drawn into the swamp forest and attached to the felled trees. The engine then snakes the trees to the canal.

A larger boat and engine at the central point snake the logs down the radial canals. At the center the logs are piled on boats and taken out of the swamp. Sometimes boats are used on the radial canals for transporting the logs instead of snaking them with cables.

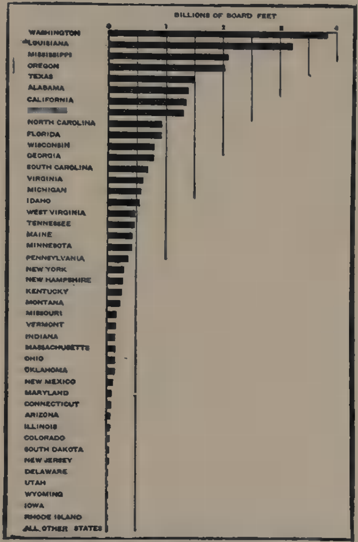
559 Pull Boat in a Louisiana Cypress Swamp, from a photograph by the United States Forest Service

RAFTING LOGS

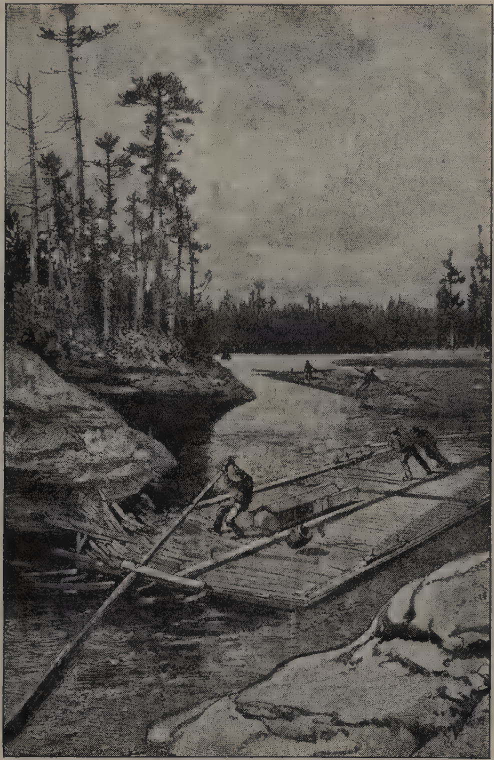
UPON the larger streams in the Gulf region logs are formed into rafts. These float downstream with the current, guided by great oar sweeps or towed by steamboats.

PLACE OF THE SOUTH IN LUMBER PRODUCTION

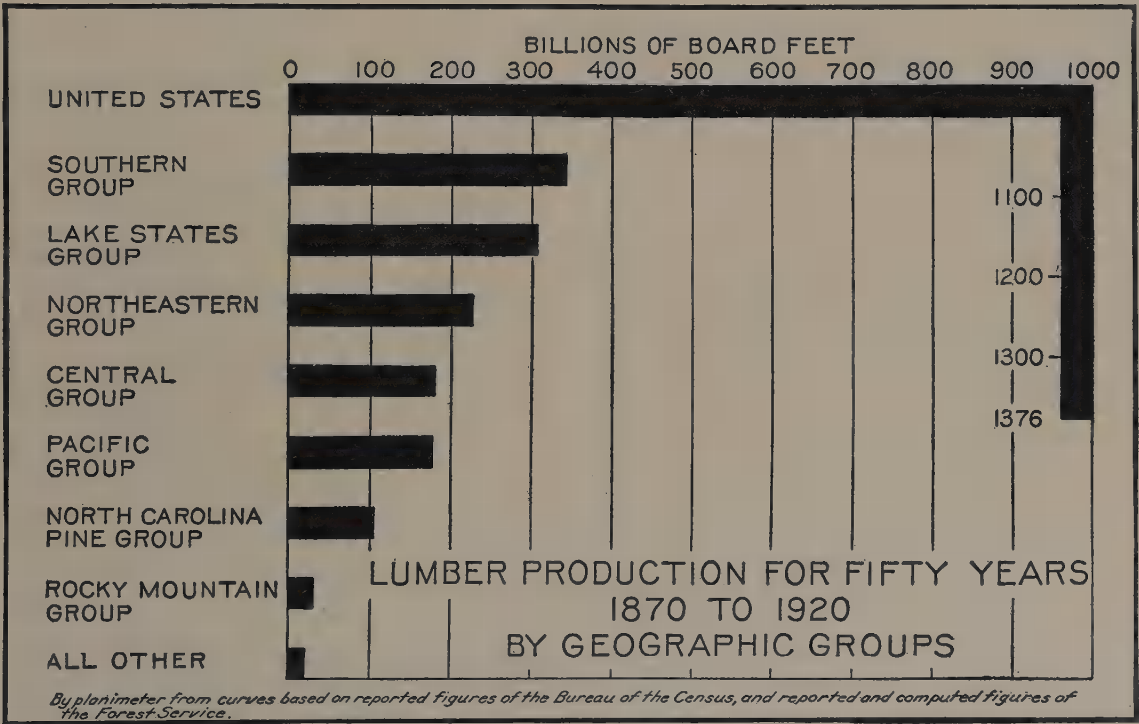
THE South Atlantic and Gulf forests have already passed the peak of their production, but even now these two regions supply half of all soft woods and more than a third of woods of all varieties. Four-fifths of the original yellow pine has already been felled and what remains is being logged three times as fast as it is grown. With increasing manufacturing and agricultural industries, the South will soon have use for all the yellow pine it can produce. The swamp forests of the Gulf reached their maximum output in 1913 and it is estimated that another ten years will witness their extinction.



561 From *The Census of Manufactures, 1921, The Lumber Industry,* Washington, 1923



560 From *Harper's Weekly*, June 5, 1886, after a drawing by Charles Graham



562 From *Bulletin* 1119, the United States Department of Agriculture, 1923

563 From a photograph by the United States Forest Service

HARDWOOD FOREST, NORTH CAROLINA

In the southern Appalachians, southern Ohio, Indiana and Illinois, and in the Ozarks, is found a unique forest region. This forest is composed of hardwoods in solid stands, a situation unknown elsewhere in the world. These stands are mixtures of oak, chestnut, walnut, cherry, hickory, basswood and the like. Elsewhere the hardwoods are generally in the hands of small owners and logging operations are on a correspondingly small scale. Since hardwood grows on good soil and the land has been more valuable for farms than for forests, about four fifths of the original sixty million acres of hardwood have been sacrificed. What remains is largely in the southern Appalachians.

LOGGING IN THE ROCKIES

The Rocky Mountain forest is unevenly distributed and discontinuous, due to the character of the country, its altitude and rainfall. The trees are soft woods, chiefly Douglas fir, western yellow pine, lodgepole pine and larch. They were cut first in the early 'fifties to supply mining operations, but to-day much of the product is shipped eastward to markets in the Middle West and on the Atlantic seaboard. Every type of logging found elsewhere in the United States, except swamp logging, is to be discovered in the Rockies.

564 From a photograph by the United States Forest Service

565 From a photograph by the United States Forest Service

SLIDING LOGS DOWN A FLUME, WYOMING

MANY of the areas in the Rockies are so precipitous that the only means of transportation is to slide the logs downhill in a log or board chute. Where water is available the chute is made watertight and in this flume the logs are dumped to float and slide down the mountain side to the sawmill. The picture shows a flume with log skids alongside ready to shove logs into the current. A flume operates faster than a chute because the water offsets friction.

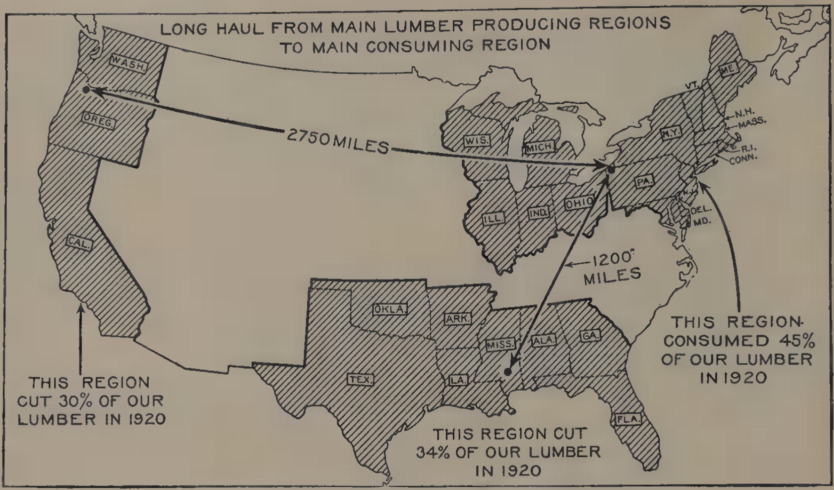
556 From a photograph by the United States Forest Service

RANCHER'S SAWMILL, MONTANA

MUCH of the Rocky Mountain forest has been put into the national forest system. Since this system encourages small-scale logging operators, a good many ranchers use their spare time as lumber cutters and sawmill enterprisers.

THE PACIFIC LUMBER FIELDS

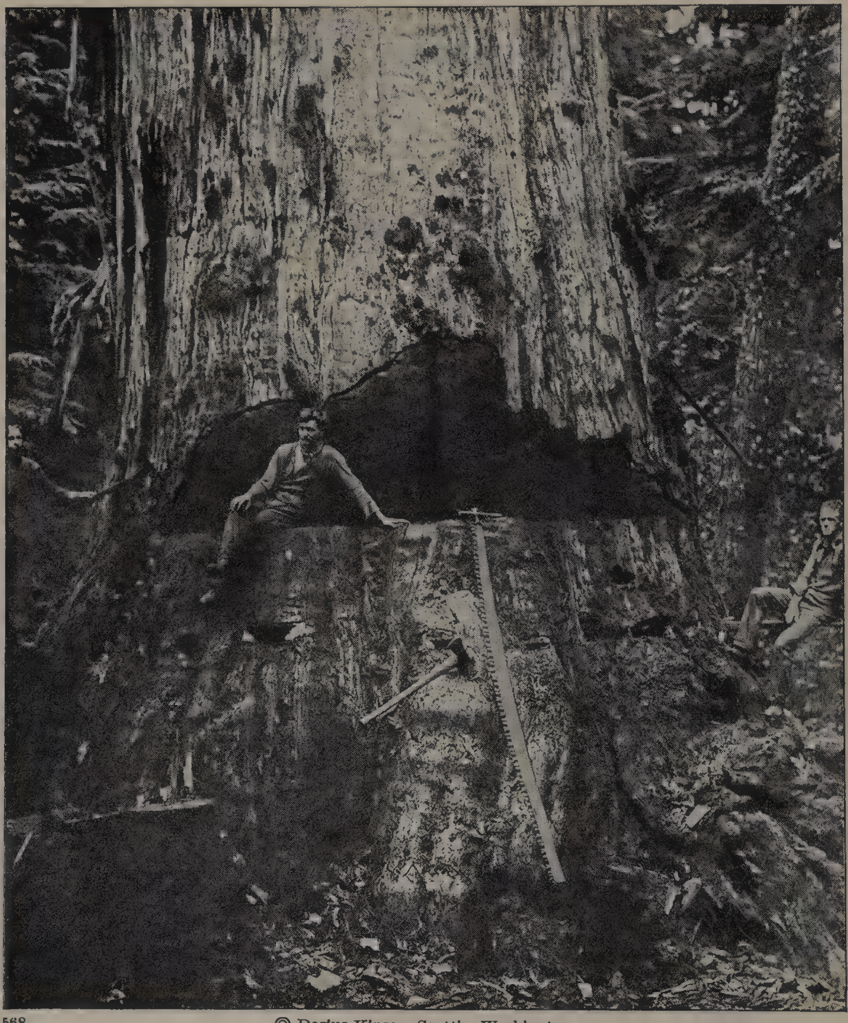
The last great timber region of the United States is the Pacific coast, where almost a third of our remaining forest now stands. The first cutting of any importance in this region was in 1845 on Puget Sound. Within ten years lumbering became and still remains the principal industry of Washington. The business was local until 1894, when the Hill railroads reduced rates on eastbound forest products, a move which brought the Pacific coast logging and lumber industry into national fame. Washington became the leading lumber state in 1905 and has never been displaced from that position since, except in 1914 when Louisiana overtopped it. Douglas fir is the leading tree in the Pacific logging operations, although half a dozen other varieties compete with it.



567 Courtesy of the United States Department of Agriculture

A BIG TREE, WASHINGTON

The outstanding characteristics of the west coast forest are the gigantic size of the trees and the jungle-like growth that they attain. Nowhere else in the United States have climate, rainfall and altitude so happily combined to produce such forest giants. This Washington tree was seventy-six feet in circumference, measured one and one half feet from the ground. In California, in a national park carefully preserved from the lumberman's ax, is a group of trees even larger than this. The enormous size of so many of the Pacific coast trees raised serious problems for the lumberman. But men with their puny axes, wedges and saws have brought these huge giants to earth.



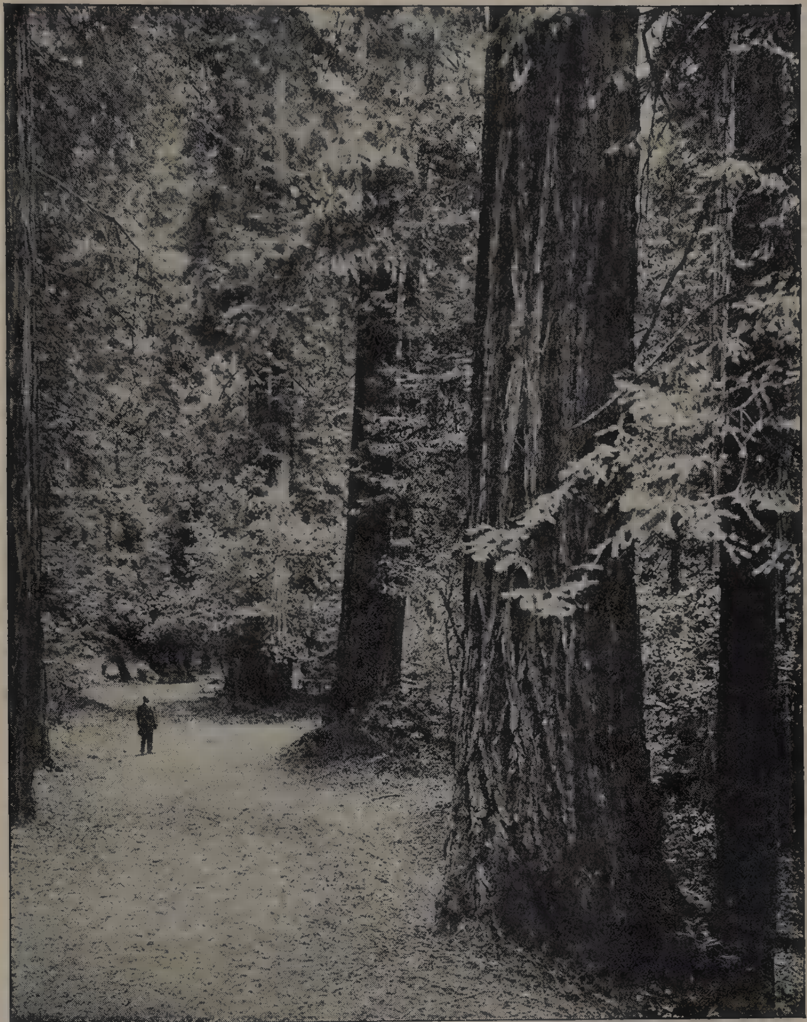
568 © Darius Kinsey, Seattle, Washington

CALIFORNIA REDWOODS

THERE is a relatively small specialized forest north of San Francisco known as the Redwood Area. The redwood tree is large in size and the lumber is valuable because it is well-nigh fireproof and insect proof. Save for the part which is set aside as a national park, the area is carefully logged. The redwood is the noblest of the trees. Its majestic trunk and towering height have never failed to arouse awe and wonder in the minds of all who have passed through its forest aisles.

A BUNK HOUSE ON RAILS

THE Pacific coast lumber camps are sometimes made up of shacks like those in the South Atlantic forests. Some too are houses constructed on railway trucks and moved from place to place as need arises. Towns like this are to be found also in the South Atlantic forest.



569 From a photograph by the United States Forest Service

570 © Darius Kinsey

571 Courtesy of the West Coast Lumbermen's Association, Seattle

CUTTING THE TOP OFF A SPAR TREE

One type of West coast felling involves "topping" the trees. Trees that are to be used for spars must have the top removed before the tree itself is cut. This is to prevent breaking during the fall at a point below that requisite for the maximum length of the spar. The "tops" that are cut off are as large as many trees cut elsewhere in America. The task of cutting these tops is not one to be undertaken lightly or inadvisedly. The lumber jack here becomes a steeple jack.

LOG DRAGGED BY A TEN-HORSE TEAM, WASHINGTON

The difference in topography in the timber regions of the Pacific coast calls for a variety of methods of transporting logs. Where the cutting area is near a railway line the logs are often dragged along the ground by horses to the skid, a log structure beside the rails upon which the logs are to be piled awaiting shipment by car. Notice the great waste of power — ten horses and four men — to move one log by this method. This waste and hence cost prevents the method from being used except for short hauls. Even when the logs were small enough to be drawn by two horses, the friction between the log and the bare ground made this a costly method of haulage.

572 From a photograph by the United States Forest Service

573 From a photograph by the United States Forest Service

DONKEY ENGINE SNAKING LOGS IN A CHUTE

An improvement over horse traction is the grooved track or chute, itself made of logs, used as a guideway for the log's travel; the motive power is a stationary steam engine from which cables are run to the log to be moved. Horses are used also in connection with these chutes on the less difficult grades.

574 © Darius Kinsey

STEAM SKIDDER HOISTING A LOG

Steam power exerted through blocks and cables is used to pick up and carry logs from one place to another and to pile them on a skidway to await further transportation.

575 © Darius Kinsey

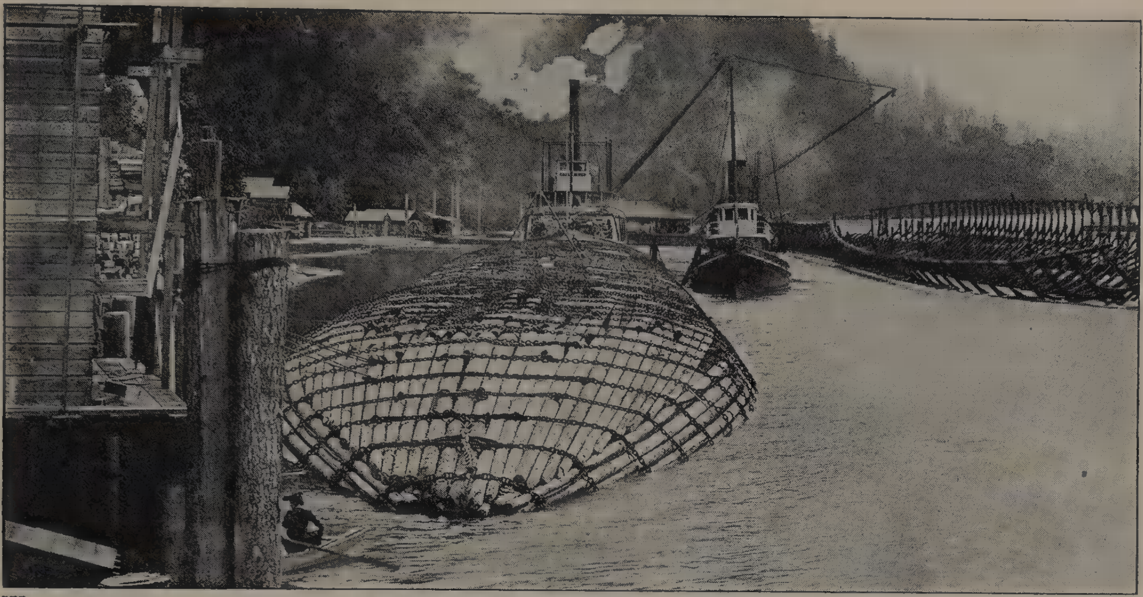
576 From a photograph by the United States Forest Service

LOADING LOGS ON TO FLAT CARS

STEAM skidders and loaders at the upper right load logs on flat cars of a logging railway. The railway may take the logs to a sawmill or to a standard railway for further transportation. These logs are so large that one fills a car.

A LOGGING RAILWAY INCLINE, WASHINGTON

MANY topographic difficulties must be surmounted by the logging railways. The locomotive is here dispensed with, and a cable attached to a stationary engine at the top of the grade controls the carloads of logs on the hill.



577 Courtesy of the West Coast Lumbermen's Association

A CIGAR RAFT ON THE PACIFIC COAST

THE rivers, sounds and coast waters of the Pacific region are employed to float logs to a sawmill. The logs are made up into great rafts and either float with a current or are towed by steamboats.

Similar rafts are to be seen on the Great Lakes and Mississippi River and once in a while elsewhere in the United States. Storms break up these rafts and scatter the logs in all directions to be a menace to shipping.

578 © Darius Kinsey

AMERICAN LUMBERMEN

THE labor force of our lumber camps is made up of a surprising number of Americans. In the hardwood area about eighty-five per cent of the labor is American-born, and on the Pacific coast about sixty per cent are Americans, while in New England only a little less than half of the woods force is American. The southern section of the Rocky Mountain forest is manned predominantly by Americans. The forest still has its unique appeal to the venturesome American blood.

579 © Darius Kinsey

A GROUP OF FINNS

NEXT to Americans, Finns are the most familiar type to be found in lumber camps. They are most numerous in New England and the Lake states but may be discovered in all of the northern forest region.

580 © Darius Kinsey

SWEDISH LUMBERMEN

AFTER the Americans and Finns, the Swedes are our lumbermen. In Sweden itself there is an extensive forest industry so it is not astonishing the sons in America take to the wood industries. The Swedes are most numerous in the lumber camps of the Lake states.

GERMAN LOGGERS

AMONG the minor national elements discoverable among tree cutters and sawmill men are Germans (No. 581), Austrians, and Russians. New England and Lake state forests attract these nationalities in the largest numbers. They are seldom encountered elsewhere except occasionally on the Pacific coast.

581 © Darius Kinsey

582 © Keystone View Company

FRENCH CANADIANS IN THE MAINE WOODS

FRENCH CANADIANS in small numbers — about five per cent of the total — may be seen (No. 582) in the forests of New England and the north Rocky Mountains. They make excellent loggers but find sufficient market for their abilities in Canadian forests, so that not many of them drift across the line into American camps.

NEGRO LUMBERMEN, GEORGIA

IN the South, both along the Atlantic and upon the Gulf, the outstanding lumber worker is the negro. A few Mexicans are encountered also, but about eighty per cent of all the labor is made up of colored men. No other men could stand the strenuous work of logging in the heat and humidity of our southern forests and, furthermore, no other great source of labor is available in these regions.

583 From a photograph by the United States Forest Service

584 © Darius Kinsey

JAPANESE LOGGERS

Upon the Pacific coast there are a few Japanese loggers scattered through the various camps. The Japanese in this section of the country take more kindly to truck gardening.

585 © Darius Kinsey

ITALIANS

Italians, likewise, are extremely rare among our logging workers. They are occasionally seen on the Pacific coast and in the forests of the North and South Atlantic.

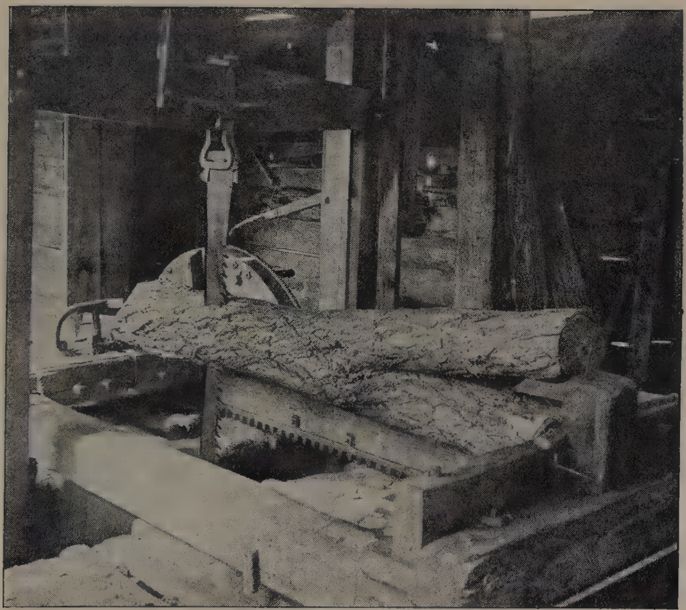
PRIMITIVE SAWS

THE destination of the logs is the sawmill, where they are cut into lumber or other wood forms. These mills are everywhere about the same in essentials, although they vary in size. Small mills usually predominate because they can get close to the cutting area, may be portable, are easily changed to accommodate different conditions and represent the least capital investment. More than two thirds of all the sawmills in the country are small (less than 500,000 board feet capacity).

The simplest and most ancient method of sawing logs was by means of the whipsaw or sawpit, a method well known in every pioneer community in America and still found in certain remote parts of the Appalachians and perhaps elsewhere. The log is generally squared roughly with a broadax and elevated a little above man height on a trestle. The variant is to place the log over a pit, hence the two names "whipsaw" and "sawpit." In either case one man stands above on the log and pulls the saw upward while another stands below and pulls the saw down. The cutting stroke is the downward one. The saw itself is somewhat like a gigantic "bucksaw." A mark along the upper side of the log guides the worker. From one to two hundred feet represents the amount of lumber that can be sawed in this way in a day.

586 Whipsaw, Pennsylvania backwoods, from a photograph by the Pennsylvania Department of Forestry

587 A Sawpit, from *The Book of English Trades*, London, 1818



588 Primitive Mill with an Up and Down Saw, Pennsylvania, from a photograph by the Pennsylvania Department of Forestry

THE UP AND DOWN SAW

THE first advance over the whipsaw or sawpit in this country was to house a saw in a shelter and operate it with an up and down motion by means of water power. The saw was attached to a wooden beam which in turn was joined to a crank on a water wheel. The other end of the saw was held taut by hitching it to a spring pole. The beam traveled up and down between side blocks which tended to steady the motion. The log was mounted on a crude carriage and moved forward against the saw by a ratchet. The early sawmills of the country in pioneer settlements were generally of this type. Such a saw was able to turn out between five hundred and one thousand feet of lumber in a day.

589 From a photograph by the United States Forest Service

A DOUBLE EDGE SAW

To save the waste involved in an up and down motion, circular saws have been introduced, and saws made of flexible bands running over a pair of wheels. Likewise the carriages for holding and moving the logs have been improved, and movable tables or chains for transporting material about a mill have been evolved. On the double edge saw are the mechanical "dogs" that hold a log on the carriage which moves forward under power on its own track. But there is not much that is complicated about a sawmill, even of large scale.

590 From a photograph by the United States Forest Service

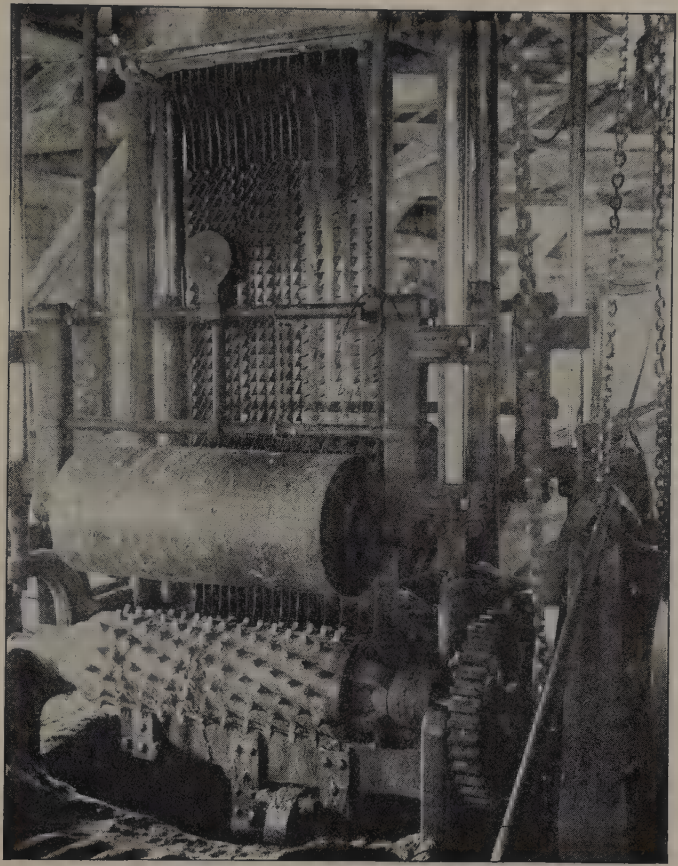
A BAND SAW, VIRGINIA

An interesting type of saw is a band saw running over a wheel. A corresponding wheel under the floor keeps the band taut and permits its complete circuit. This picture also shows how logs are "squared" before being sawed with another saw into boards.

A GANG SAW, MAINE

To avoid the necessity of moving a log carriage back and forth to cut boards from it one at a time, it is possible to saw a log at one operation into as many boards as it contains. For this purpose a whole row of saws are set up together as far apart as the desired thickness of the board, and then at one forward movement of the carriage the whole log is sawed into boards. Such saws are called "gang saws."

The carriage must move the log against the saws slowly to give time for the cutting action, but if they returned just as slowly much time would be lost; mechanism has been devised to jerk the carriage back into position to receive another log.



591 From a photograph by the United States Forest Service

A SMALL PORTABLE SAWMILL

A PORTABLE sawmill outfit may be very small. There are scores of such simple arrangements in operation in the logging country. They make it possible after a big logging operation has cut over an area to go in and clean up the odds and ends of trees left by the larger operation.

592 From a photograph by the United States Forest Service

593 From a photograph by the United States Forest Service

SMALL PERMANENT MILLS

A SOMEWHAT larger outfit, partly protected from the weather, may be found in some forests. Though it is portable, it is designed to stay longer in one place. A still larger and more permanent mill may be seen below with its smoking kiln of brick at the right for the drying of the shingles cut from the surrounding forest. From a distance such equipment seems rough and crude, but to come closer and to examine the smoothly running carriage and the gleaming saw that wails as it cuts the log from end to end is to discover that man has brought his machines even to the wilderness. The sawmill is a busy, noisy place filled with the smell of sawdust and of uncured lumber.

594 © Darius Kinsey

595 © Darius Kinsey

MODERN LARGE-SCALE SAWMILL

Large mills are most frequently encountered on the Pacific coast where the size of the logs requires expensive machinery, and where lumber holdings are largest. In the southern states for similar reasons large mills are often seen. On the west coast about a third of the mills are large-scale and in the South about a fourth would be similarly classed. Hardly a tenth of the mills elsewhere could be called large and in New England or the Rocky Mountains it would take long and diligent search to find a large sawmill.

The manufacturing process is about the same everywhere. It consists of squaring the log — that is, trimming off the bark and a narrow piece of the wood — sawing the log into forms, disposing of the forms and removing the waste. Saws and movable chains are the essential and universal mechanism employed.

The interior of a modern large-scale shingle sawmill looks little like the small-scale one but resembles any large-scale manufacturing industry in which machinery plays a large part.

SAWMILL AND POND, LOUISIANA

A large-scale sawmill, viewed from across the pond in which the logs are retained until sawed, does not look unlike a steel plant. Although few in number such mills saw about two-thirds of all the lumber in the country. One mill may saw as much as 100,000 board feet of lumber in a day. This is a thousand times as much as a whipsaw pair could do in a day and about twice as much as the small outfits turn out in a month. Yet the large mill is temporary. With the passing of big timber and large logging operations it will go. The dome-shaped structure at the left is for burning refuse wood. In thickly settled districts some of the refuse may be sold or given away for firewood. If the wood is of the proper sort, some of the refuse may be distilled.

596 From a photograph by the United States Forest Service

597 Courtesy of the Great Southern Lumber Company, Bogalusa, La.

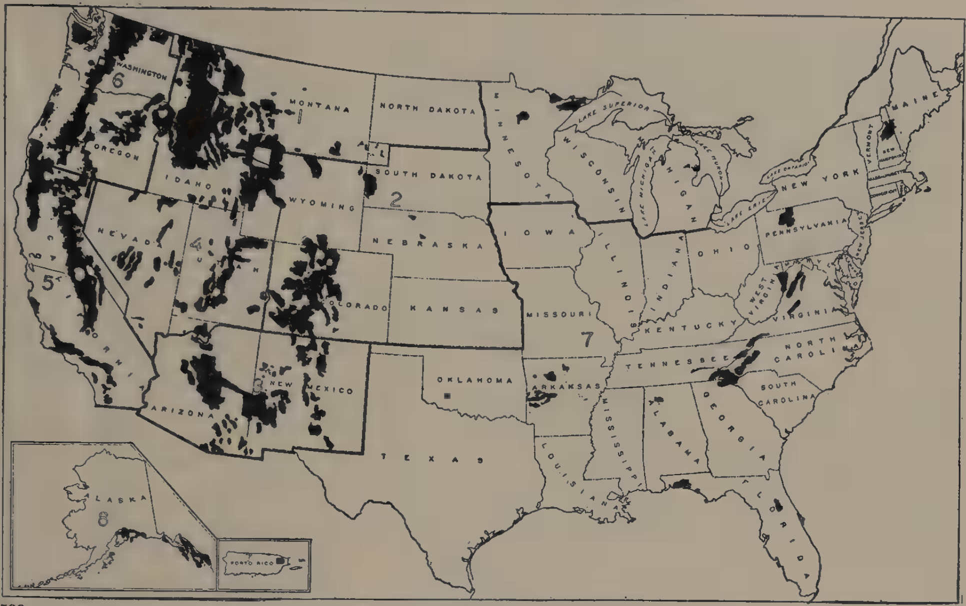
DRYING YARD, LOUISIANA

AFTER lumber is sawed in a mill it must be "cured," that is, it must be permitted to dry and season. To save time, this is sometimes done in a "kiln." A slower but better method is to pile the lumber out in the air in such a way that the air can circulate around the lumber and gradually dry and season it. Sometimes a shed roof is erected above the piles but the sides are left open to the air.

598 From a photograph by the United States Department of Agriculture

AFTER THE AX, THE DESERT

THE sacrifice of timber to pay taxes and carrying charges on the land, the isolation of timber lands causing logging operations to be carried on continually regardless of the market, fire, and the competition between regions, have all contributed to the butchery of American forests. The amount of waste land formerly in forest is an area greater than the combined forest lands of France, Belgium, Holland, Denmark, Germany, Switzerland, Spain and Portugal. And we are adding to this idle land at the rate of ten million acres a year.



599 Courtesy of the United States Forest Service

UNITED STATES NATIONAL FORESTS

It was not until 1891 that the nation took its first step toward a wise forest policy. In that year a five-line rider on an irrelevant act authorized the President to withdraw public forest lands from private exploitation. This well-nigh surreptitious authority was seized immediately by the President and the policy of reservation began. The words "forest reserves" have a psychological interest because they indicate the original purpose of national forests, namely to withhold them from use until future times. Gradually public opinion has inclined to the view that the purpose of reserving forests for the future is not inconsistent with their use in the present. So long as the cut each year does not exceed the annual growth, the forest as a whole will be preserved. Indeed, judicious cutting is advantageous in promoting growth. In 1907, to escape the implication of the name "reserves," Congress changed it to "national forests." By 1922 as much as twenty-one per cent of all standing timber had been brought under governmental authority. The total area of reserves — one hundred and eighty million acres — is larger than Texas.

GOVERNMENT FIRE OBSERVATORY, COLORADO

But the ax and saw have not been more destructive to trees than fire. The annual loss due to this cause is equal to three per cent of the total amount of wood consumed, and measured in dollars is equivalent to twenty-five millions. Lightning, the carelessness of campers, sparks from locomotives, lighted objects thrown from car windows, lumbering heedlessness, and incendiarism are important causes of forest fires. Trees that are not consumed are so injured that they die and the very soil of the forest floor is either reduced in fertility or left sterile. The first step in conservation is provision for fighting fire. From watch towers, raised high above the forest, a constant lookout, for fire or smoke, is maintained.

600 From a photograph by the United States Forest Service

CHAPTER XI

THE MAKING OF PAPER

MEN have recorded their deeds and thoughts upon stones, flat surfaces of baked clay, boards, the impressionable surface of parts of plants, wax, skins of animals, papyrus, and parchment. But the most important material to preserve writing and printing has been paper.

Paper has been manufactured from some four hundred different fibrous raw materials by reducing the fibers to a pulp and then pressing the pulp into a sheet. To make a smooth surface, minute spaces in the pressed and dried pulp sheet have been filled with a variety of substances. Despite the kinship of the words the Egyptian papyrus was not the original "paper." Although papyrus was a writing material, it was manufactured by slicing the stalk of a rush-like plant into thin longitudinal sheets and gumming these sheets together. This process was essentially different from that employed in manufacturing paper, wherein fibrous raw materials are first reduced to a pulp before being formed into a sheet. That is, papyrus was a sheet derived from nature, whereas paper is a sheet made artificially.

The Chinese are credited with the invention and use of real paper about 95 A.D. Paper making was introduced into Europe when an Arabian tribe, the Saracens, conquered Spain in the eighth century. The Arabians gave Europe both the paper and the numerals to put upon it, so one might say they were the founders of the world's great army of bookkeepers. From Spain the art of paper manufacture spread northward into the Low Countries and Germany.

Since European paper was manufactured from linen rags, and inasmuch as the British clothed themselves in wool or leather, the British were among the last Europeans to make their own paper; indeed, they did not establish the industry until 1688, just two years before the first paper mill was set up in America. This being the case, it was not the British colonists that one would expect to inaugurate paper manufacture in America, but rather the Dutch and Germans who had settled in Pennsylvania, and it was here that paper manufacture was begun in 1690.

The development of the making of paper has been controlled by certain changes in American life. The greatest of these has been the increase in population and along with it the rise of the newspaper and the magazine. As the nineteenth century drew to an end newspapers and magazines began to increase in number and in circulation. The twentieth century has seen an expansion in this field without precedent in world history. The demand for cheap paper has been enormous. Wood pulp has offered the best solution to the problem, and armies of axmen have invaded the dwindling forests to supply the need. The demand for high grade paper has increased with the growth of population and the mounting wealth of the nation. The business of making paper has become a most important national and international enterprise.

Like most ancient arts, paper making at first was a handicraft and a highly skilled one. For a thousand years after the art was introduced into Europe the hand paper maker ruled supreme in the business. Compared with this long record of handwork, it was only yesterday that mechanical appliances entered this industry. But in few arts was the shift from manual to mechanical operation so complete when it first took place.

601 The Third Rittenhouse Mill, built *ca.* 1770, from a photograph *ca.* 1897, courtesy of the Lockwood Trade Journal Company, New York

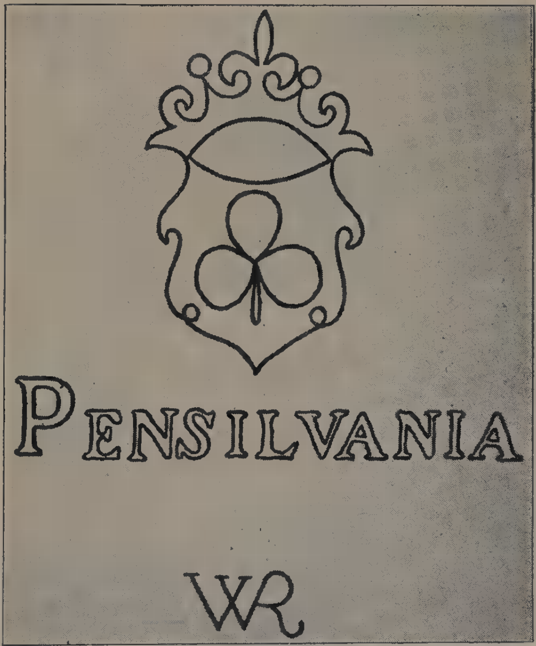
THE FIRST PAPER MILL IN AMERICA, 1690

Paper manufacture began in America as a result of the personal ambition of two men. One of these was William Bradford, an Englishman who set up a printing establishment in Philadelphia, and became the first really great printer and publisher in America. Hampered by his dependence upon Europe for paper, he went into partnership with William Rittenhouse, a Rhenish German, whose ancestors, as well as himself, were paper makers. The partners, Bradford and Rittenhouse, together with three other men who furnished the necessary capital, leased land and erected a mill on Wissahickon Creek at Germantown, near Philadelphia, in 1690. There the first paper in America was made. Rittenhouse, the practical man of the partnership, had bought out the other partners by 1704 and so became sole proprietor of the enterprise. The first small mill was destroyed by a flood in 1701, but a second was erected during the next year. Four other paper mills were built in the same vicinity by members of the Rittenhouse family of different generations. The third mill, shown above, remained standing until the close of 1900. The site of these famous Rittenhouse mills is now part of Fairmount Park, Philadelphia.

AN EARLY WATERMARK OF THE RITTENHOUSE MILL

Paper makers distinguish their product by what is called a "watermark." This, like the mark "sterling" silver, is a relic of craft guilds. The watermark first appeared in European paper in 1498. The paper watermark is produced by placing a wire pattern in the wet pulp before the paper sheet is formed. This thins the pulp at that point and produces a design that may be seen when the sheet is held to the light.

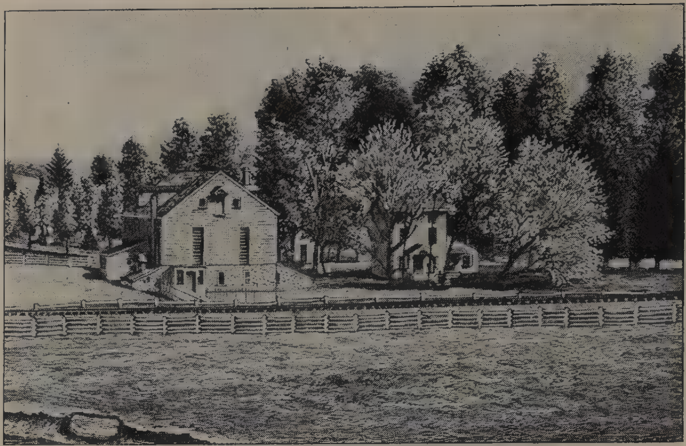
The first watermark used by William Rittenhouse was the one word, "Company." It was replaced by the mark shown here, the design of which consisted of a *fleur-de-lis* bearing on its face a clover leaf, the town shield of Germantown. Rittenhouse watermarks can be found on many books, letters and newspapers of the early eighteenth century. The *New York Gazette*, begun in 1725 by William Bradford, bears a Rittenhouse watermark. The mark of the Rittenhouse mills can also be found on the paper of the *American Weekly Mercury*, begun at Philadelphia in 1719 by Andrew Bradford.



602 Facsimile from *The Pennsylvania Magazine of History and Biography*, Philadelphia, 1896

THE WILLCOX IVY MILLS, 1729

The paper-making enterprise of William Rittenhouse was imitated in the same neighborhood in 1710 by William De Wees, a connection of Rittenhouse by marriage. The third important venture in paper manufacture was not inaugurated until 1729 when an English immigrant named Thomas Willcox, trained as a paper maker, built a paper mill on the west branch of Chester Creek near Philadelphia. Thomas Willcox and his son Mark made paper in this mill continuously for ninety-eight years, and grandsons carried it on until 1854. Paper for Benjamin Franklin was manufactured in the Willcox mill, and paper for bank notes for the United States and various state and foreign governments was also made there. The Willcox mill identified its product by a watermark of the dove and olive branch. The second Willcox mill was built one hundred years later, but upon the same site and foundations.



603 The Second Willcox Mill, 1829, from Henry Graham Ashmead, *History of Delaware County, Pennsylvania*, Philadelphia, 1884

604 An Early Watermark of the Willcox Mill, facsimile from the Lancaster County Historical Society *Papers*, Vol. I, 1897

THE FIRST PAPER MILL IN MASSACHUSETTS, 1728

The readiest market for domestic paper was in Boston, which had the largest number of printers, yet there was no effort to establish paper making in Massachusetts until after there were three mills in Pennsylvania, and one in New Jersey.

Skilled paper makers were lacking in New England and rag raw material was not so easy to secure as in Philadelphia, then the largest American city. Furthermore, New England's prosperous commerce enabled that section to import easily what paper was needed.

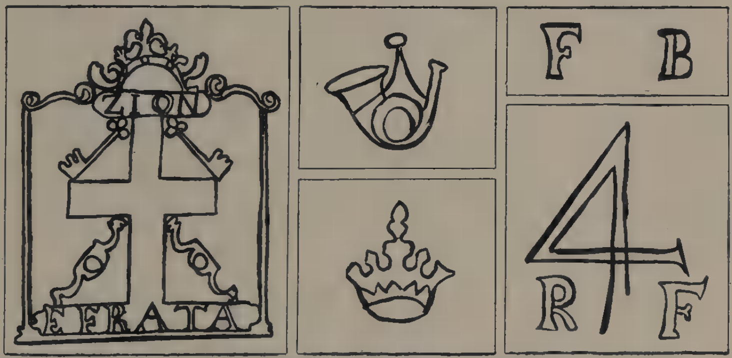
605 From a sketch made for the Old Colony Trust Company, Boston

In 1728, however, a group of prominent citizens in Massachusetts petitioned for and received from the General Court a charter to manufacture paper and to obtain a ten-year monopoly in the same. The prime movers in this petition and grant were Daniel Henchman, a wealthy bookbinder, bookseller and publisher of Boston; Henchman's son-in-law, Thomas Hancock, another bookseller and uncle of the signer of the Declaration of Independence; Benjamin Faneuil, father of Peter Faneuil; and Henry Dering, a practical mill man. A mill was built at Milton, where paper continued to be made for three-quarters of a century.

606 The Ephrata Paper Mill (left corner), from a photograph, 1890, by Julius F. Sachse

THE PAPER MILL OF THE EPHRATA BROTHERHOOD

THE Milton, Massachusetts, mill was followed by others both in Maine and Massachusetts, but except for local fame they did not vie with the mills around Philadelphia. Meanwhile the Pennsylvania industry had had another mill added to its roll. This one was noteworthy because started by a branch of the Pietists of Germany, who had settled in Pennsylvania and organized a communistic social settlement called Ephrata. The Ephrata mill was built about 1736 and continued in operation as late as 1784. At one time the Ephrata mill was the largest producer of paper in all the colonies. One of the most famous books printed on Ephrata paper was the Christopher Saur Bible of 1743, the second Bible in America and printed in German.

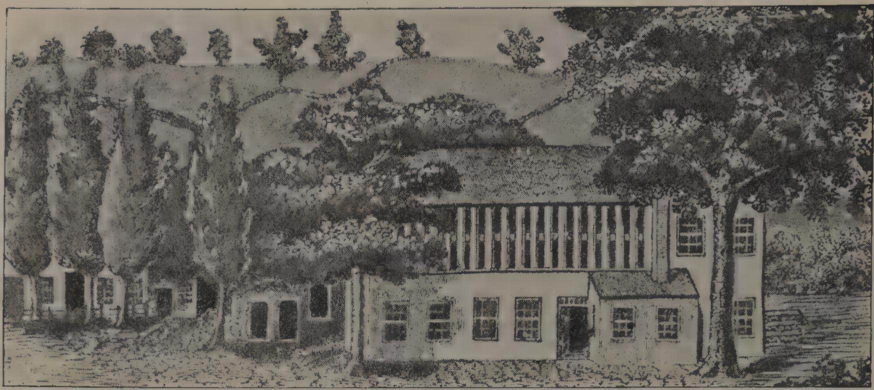


607 Ephrata Watermarks, from Julius F. Sachse, *The Ephrata Paper Mill*, in Lancaster County Historical Society *Papers*, Vol. I, 1897

THE FIRST PAPER MILL IN CONNECTICUT

CONNECTICUT had no paper mill until 1766, when Christopher Leffingwell erected a mill at Norwich on the Yantic River at the head of the Thames. This mill made all kinds of paper, including cartridge. An account of the battles of Lexington and Concord was printed upon Leffingwell paper in 1775 by the *Connecticut Gazette*. The mill was still operated within the memory of living men. A century after the founding of the Leffingwell mill Norwich had the largest newsprint paper mill in America.

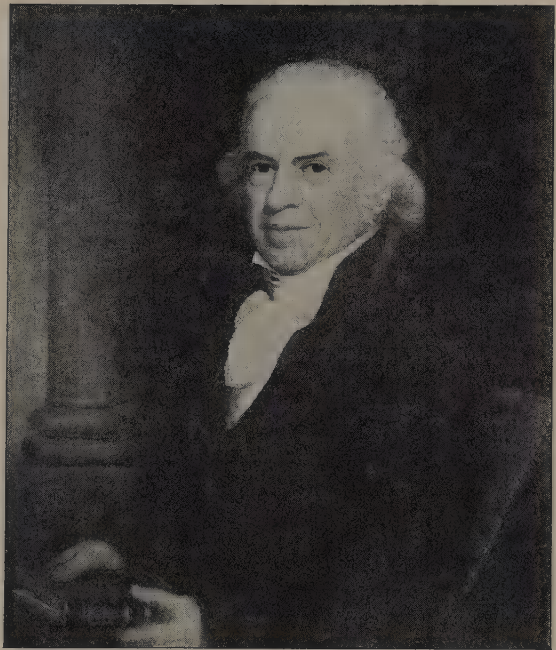
608 Christopher Leffingwell, 1734–1810, from silhouette formerly in the possession of W. P. Huntington, Columbus, Ohio



609 The Thomas Paper Mill, built 1793, from the *Proceedings* of the Worcester Society of Antiquity, 1886, after an old woodcut

ISAIAH THOMAS, 1749–1831, A NOTED PAPER MANUFACTURER

Isaiah Thomas, one of the foremost printers and publishers of his day, was the producer of several editions of the Bible, besides many books dealing with law, history and philosophy. Four newspapers were among his enterprises, one of which, the famous *Massachusetts Spy*, caused him to flee from Boston to escape seizure by the British during the Revolution. He started his business again in Worcester, but finding it difficult to transport all the paper he needed from Boston, he endeavored to interest local people in paper manufacture. Two mills were eventually started as the direct result of Thomas' insistence: one at Sutton, built in 1778, the other at Worcester in 1793. These were the first paper producers in central Massachusetts, and they led the industry from the New England coast towns westward to the Berkshire valley, at a later day the most famous center for paper manufacture.



610 From the portrait of Isaiah Thomas by Ethan Allen Greenwood, in the collection of the American Antiquarian Society, Worcester

READY MONEY
For Clean LINEN RAGS,
May be had from H. GAINE.

AND for the further Encouragement of ſuch poor Perſons as are willing to employ themſelves in procuring RAGS, the following PREMIUMS will be given.

To the Perſon that delivers the greateſt Quantity of good clean dry Linen Rags to H. Gaine, in the Year 1765, not leſs than 1000 lb. TEN DOLLARS, beſides being paid the full Value of the Rags.

To the Perſon that delivers the ſecond greateſt Quantity of Rags, of the ſame Kind, not leſs than 800 lb. in the Year 1765, EIGHT DOLLARS.

To the Perſon that delivers the third greateſt Quantity of Rags, of the ſame Kind likewiſe, in the Year 1765, FIVE DOLLARS.

A Book will be kept to enter the Names of all ſuch Perſons, as bring Rags, and the Quantity they deliver; and the Premiums will be paid the firſt Day of the Year 1766, by H. GAINE.

611 From *The New York Mercury*, Jan. 7, 1765

AN EARLY SCARCITY OF RAGS

Colonial paper mills were few in number and greatly handicapped. There was a great scarcity of skilled paper makers and greater dearth of mechanics trained in the arts of manufacturing paper mill equipment. But the greatest drawback of all was the impossibility of securing enough linen or cotton rags for raw materials. Advertisements urging housekeepers to save their cloth scraps yielded scant results. Prizes were offered by associations such as the American Philosophical Society to the family that saved the most rags and also to the individual whose record was highest. These prizes were in addition to the price paid for the rags. Legislation compelling people to save rags met with little response, for the colonists did not have rags to throw away, give, or sell. Consequently the paper industry, with scant supply of materials, was everywhere conducted upon a small scale.

612 The Gilpin Paper Mill, from Elizabeth Montgomery, *Reminiscences of Wilmington*, Philadelphia, 1851, after a painting by Thomas Doughty (1793–1856)

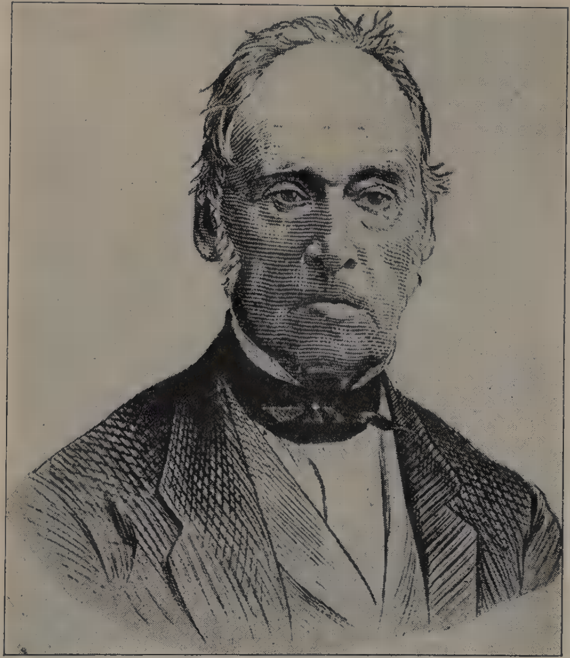
AMERICAN INVENTORS OF PAPER-MAKING MACHINERY

From 1690, when Rittenhouse built his first paper mill, to the time when power machinery was introduced, the manufacture of paper remained a small-scale, scattered industry, dependent upon the regional supply of raw material. The only important mechanism that had entered the business was a machine introduced about 1750 for washing the rag scraps, tearing apart the fibers and reducing them to a pulp. Significantly this machine was called a "hollander," a trade name still attached to it.

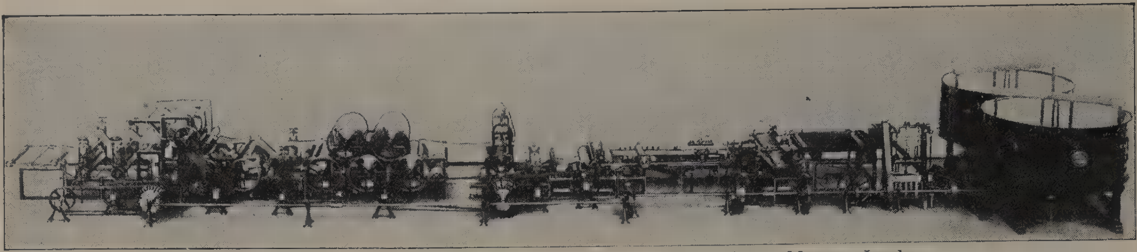
But the "hollander" merely prepared the raw material. The first machine for making paper in America was invented by Thomas Gilpin in 1816, one of two brothers who for fifty years operated a paper mill on the Brandywine near Wilmington, Delaware. Gilpin's machine was merely a cylinder, making paper continuously and in endless lengths, instead of sheets, as had previously been the case in hand manufacture.

In August, 1817, Gilpin put the machine into operation in his mill and ran off what is generally credited as being the first machine-made paper produced in this country. News of the invention spread rapidly, and for a time the Gilpins reaped a golden harvest. They made every effort to keep their machine a secret but eventually competitors learned the process, both from Gilpin workers and from similar but better machines that had come into use in Europe seven years before Gilpin's independent invention.

Another great paper manufacturer, John Ames of Springfield, Massachusetts, tried to invent and introduce a machine for making paper. It is supposed that Ames was able to learn the secret of the Gilpin machine, but at any rate he obtained in 1822 a patent for a better cylinder machine and proceeded to use it in his mill. A rival manufacturer hired Ames' foreman, and the rival soon had an Ames machine in operation. This action resulted in a long drawn legal battle over patent rights. Litigation also between Gilpin and Ames delayed the use of machinery in American paper making. As a matter of fact neither of their machines was the one finally adopted either in America or abroad. The honor of inventing the machine, now universally used for paper making, goes to a Frenchman.



613 John Ames, 1800–90, from an engraving in *King's Handbook of Springfield*, New York, 1884



614 Bryan Donkin's Fourdrinier, 1808, from a model in the South Kensington Museum, London

THE INTRODUCTION OF THE FOURDRINIER

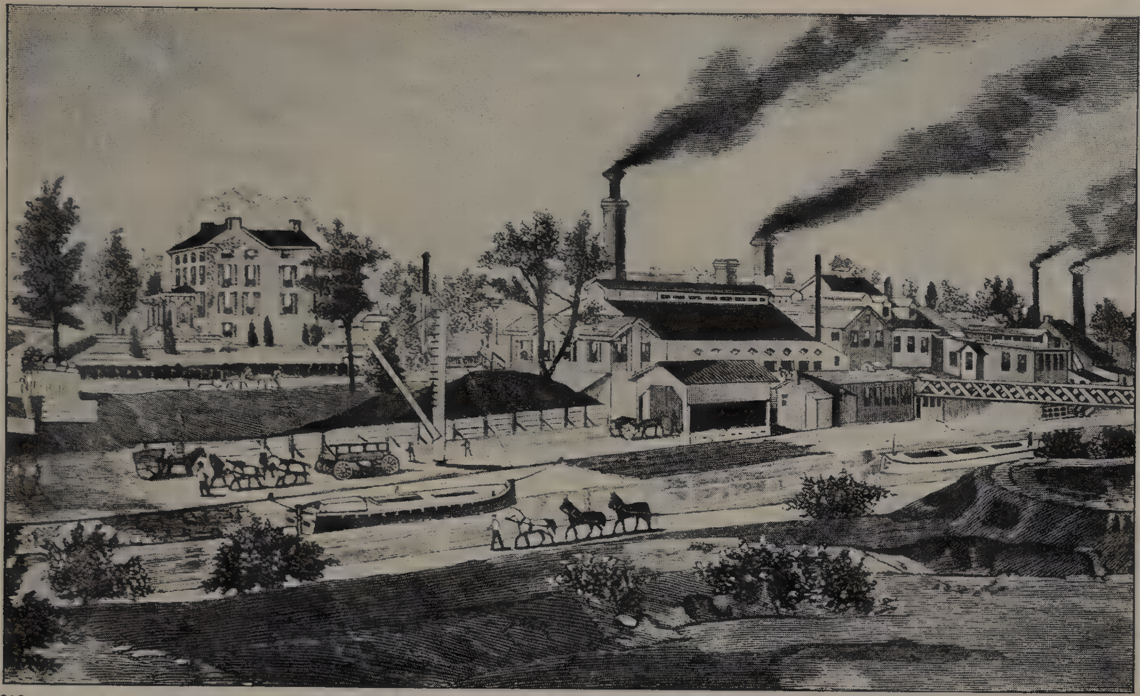
LONG before either Gilpin or Ames had invented their American cylinder paper-making machines, a Frenchman, Nicholas Louis Robert, had solved the mechanical problem of manufacturing paper in a continuous sheet by means of an endless wire band passing between two squeezing rolls. Robert, an employee of St. Leger Didot, a member of a family of famous publishers and the owner of a paper mill at Essonne, obtained his French patent in 1799. This was transferred from Robert to Didot who in turn interested his brother-in-law, John Gamble, who took out English patents on the device. In England a well-known firm of wholesale stationers, Henry and Sealey Fourdrinier, were influenced by Gamble and Didot to finance the English patents. The Fourdriniers associated with themselves a skilled machinist, Bryan Donkin by name, who took Robert's basic idea and so improved it that a new British patent was secured in 1807. The Fourdriniers sank three hundred thousand dollars in experiments, publicity and sales campaigns for the paper machine and not only brought financial ruin to themselves, but also to Gamble, Didot and Robert. The French government awarded Robert about two thousand dollars for his invention and that was all he ever got out of it. The Fourdriniers, too, in 1840 were granted thirty-five thousand dollars by the British Parliament in recognition of their contribution to the world; this small sum together with the honor of having their name attached to the machine were the sole returns to the brothers Fourdrinier. Bryan Donkin alone made considerable profit out of the device by manufacturing and selling it. The essential principles of the Fourdrinier machine have never been changed. The only improvements have been to make it longer, wider, and faster in operation.

THE FIRST PAPER MILL IN HOLYOKE, 1853

THE Fourdrinier machines were but slowly introduced into American paper mills. None were installed until 1825. The competition of the Gilpin and Ames machines retarded recognition of the Fourdrinier. Moreover, it was a costly project to import Fourdriniers from Great Britain. But by far the most important reason why machinery was so slow in making its appearance in our mills was the lack of transportation. The machines called for more raw material than any locality could procure; consequently, until communication was so improved that one town could call upon the nation for rag supplies, and, conversely, the nation could fulfill its wants for paper from the product of a few well-located mills, the advance of paper-making mechanisms was curbed.

The first effect of the Fourdrinier machine was to intensify a movement for the centralization of paper manufacture that had already begun. The establishment of the cotton industry in Massachusetts, after 1790, supplied a large amount of cotton rags in mill ends and wastes. This tended to pull the paper industry from the environs of Philadelphia to New England. Within New England, paper making was concentrating about Boston, Worcester and the Berkshire valley. The latter was assuming leadership because of an advantage in purity of water and air, when machinery entered the business and changed its destinies. The Fourdrinier was a large, heavy running machine demanding a great deal of mechanical power, such as could be obtained at Holyoke, Massachusetts, where the large volume of the Connecticut River falls seventy feet within a distance of two miles. The first firm of paper makers to take advantage of this location was the Parsons Paper Company, which began operations in Holyoke in 1853. Within a quarter of a century Holyoke became the largest producer of fine writing paper not only in this country, but also in the world.

615 The Parsons Paper Mill, from *The City of Holyoke, Its Water power and Its Industries*, Springfield, Mass., 1875

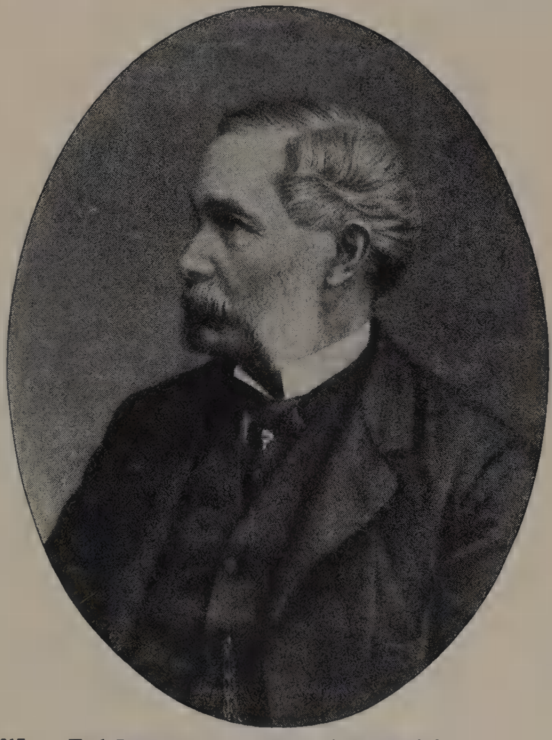


616 The Burgess Mill, Royer's Ford, Pa., from Futhey & Cope, *History of Chester County*, Philadelphia, 1881

WOOD PULP, A NEW RAW MATERIAL

The demand for paper was incessant and constantly growing. The Fourdriniers made large output possible, but the supply of rag raw material was so limited — despite importation of rags — that it held the paper industry in leash. The only way out of the difficulty was to discover a substitute for rags as raw material. Among the most promising seemed to be old rope, straw, and waste paper, but none of these solved the problem. Finally, a wasp furnished the answer. Observations upon the building of a wasp nest — so it is said — suggested the possibility of using wood for a paper raw material. The first practical process for reducing wood to pulp was by means of chemicals. The wood was chipped into small pieces, and put into a large tank with water and soda. The soda reduced the components of the wood except the fibrous cellulose which remained the basis for the making of paper.

The first successful application of this idea was made by Hugh Burgess, an English inventor and immigrant to America. In conjunction with Morris L. Keen of West Philadelphia, Burgess started the manufacture of soda pulp paper in mills constructed for that purpose at Royer's Ford and at Manayunk on the Schuylkill River within the environs of Philadelphia. The business in 1863 was organized as the American Wood Paper Company. These mills and this company, with Burgess as the guiding mind, should be credited with the first successful large-scale manufacture of wood pulp paper in America. The soda process, however, has been since almost entirely superseded by other chemical methods of "digesting" wood into pulp.



617 Hugh Burgess, from an engraving in Futhey & Cope, *History of Chester County*, Philadelphia, 1881

618 The Curtisville Mill, from a photograph, *ca.* 1897, courtesy of the Lockwood Trade Journal Company

THE FIRST MECHANICAL PULP MILL, 1867

THE manufacture of wood pulp by chemical means is slow and relatively expensive. The search for a cheaper method resulted in grinding small chunks of wood against grindstones until the wood was reduced to fine shreds which were then put through the regular pulp making processes. The first men in America to make mechanical pulp, as distinguished from chemical pulp, were the brothers Albrecht, Alberto and Rudolph Pagenstecher. These men studied the German mills where the process had been brought to some success and then tried it out in a small mill erected for the purpose in Curtisville near Stockbridge, Massachusetts, in 1867. This was the pioneer mechanical pulp mill of America.

A HUNDRED THOUSAND CORDS OF PULP WOOD

WITHIN fifty years, mechanical pulp has revolutionized the paper business, and ground wood pulp now dominates the industry. Because the grinding makes fibers small, paper made entirely of mechanical pulp is weak, so generally it has some small amount of chemical pulp or rag mixed with it to give strength. The largest market for paper is the newspaper, and nearly all newsprint and some book paper is made from mechanical pulp mixed somewhat either with chemical or rag pulp.

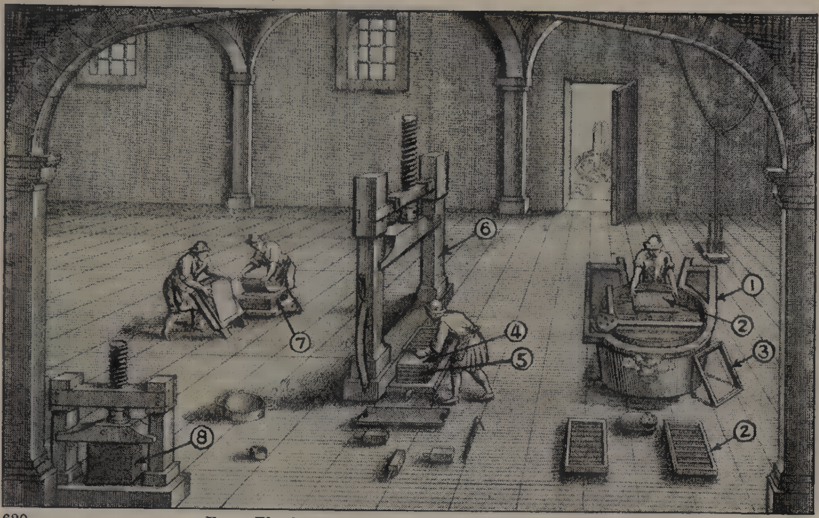
The large output of paper to-day depends upon mechanically ground wood pulp. Since it requires from sixty-six and two-thirds to one hundred horse power to grind one ton of wood mechanically and since we consume more than a million tons of wood annually in the manufacture of this variety of paper, it is apparent that cheap power is an essential.

The cheapest power is that obtained from water; consequently the modern paper industry must seek the largest available water power sites. In the past, when rags were the raw materials, paper mills were city projects; to-day they tend to become backwoods enterprises, in so far as cheap papers are concerned.

The best paper is still made from rags and the mills that produce it are often city enterprises. Chemical pulp mills too may be set up in cities, but the great bulk of the paper made is from mechanical pulp and these mills are all as close to the forests as they can get.

619 Courtesy of the Burgess Sulphite Mill, Brown Paper Co., Berlin, N. H.

MAKING OF PAPER BY HAND



620 From *The Growth of Industrial Art*, Washington, 1892

FROM the time of the building of the first paper mill in Nuremberg, Bavaria, in 1390, to the period of the introduction of mills in America, the process of paper making did not vary much in essentials. The industry has always had two parts, first the preparation of the pulp and second the making of the sheet.

The oldest practice was to take linen and cotton rags and let them ferment or partially decay in a warm damp place so that the rags could be reduced to a mash of fibers. Later the rags were put in vats or mortars, together with water, and then beaten by hand with hammers or pestles. In time these hammers were operated by mechanical power generated by a water wheel. This ended the first part of the process.

When the pulp was ready, a man called a vatman dipped it out of the vat (1) into a mold (2) — a utensil that resembled a rectangular ash sieve. A thin frame of wood fitting closely upon the mold retained the pulp and regulated the size of the sheet. This frame was called a "deckle" (3). The excess water drained through the wire. The worker shook the mold and deckle to distribute the pulp evenly, and then removed the deckle. The partly formed pulp sheet was turned carefully out of the mold on to a felt mat (4). Other sheets were laid on top with felts intervening (5). A special worker called a "coucher" did this work.

The pile of sheets containing from six to eight quires was then put into a frame (6), and subjected to heavy pressure to mat the fibers and remove excess water. The felts were removed (7) and the sheets put in another press and squeezed again (8). They were then hung up to dry. Smoothness of surface was obtained only so far as the heavy pressure produced it, and the color of the paper was the color imparted to the pulp by the original rags.

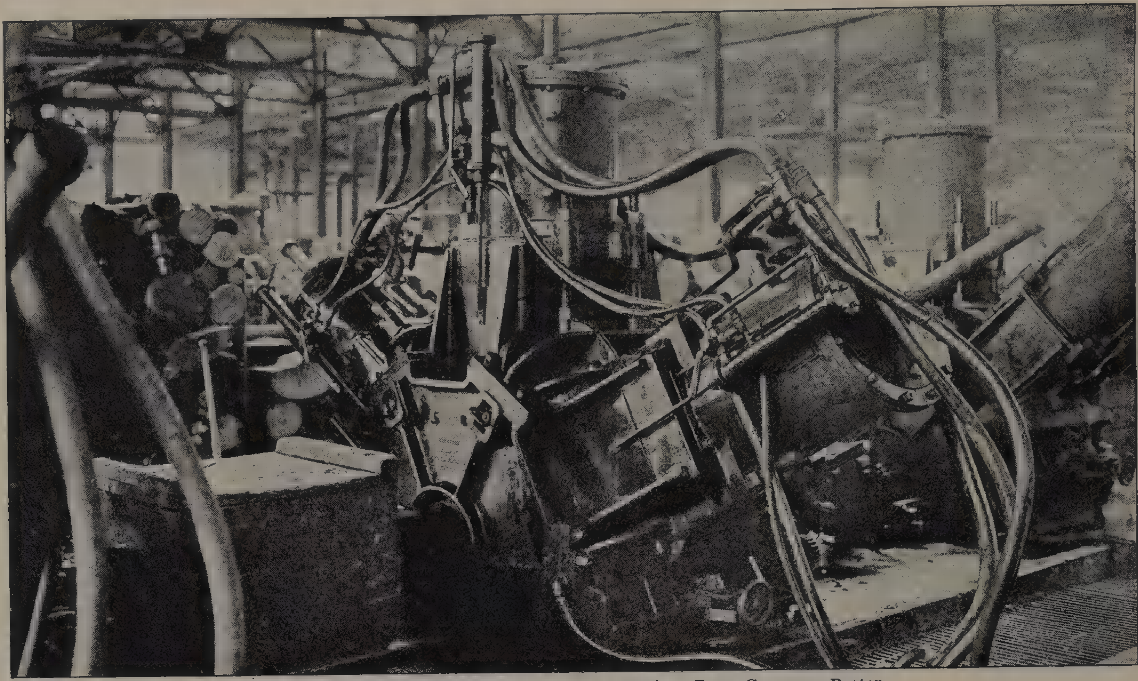
THE "HOLLANDER" BEATING MACHINE

MODERN paper is machine-made. When rags are used they are sorted, cut into shreds, cleaned, and bleached in a solution of chloride of lime. They then go to the washing machine, where blunt knives revolving on a cylinder pull the threads apart and a stream of water drains away the dirt. The "half-stock," as the mixture is now called, is then taken to a drainer where it remains until ready for the beating.

621 Courtesy of Eaton, Crane and Pike Company, Pittsfield, Mass.

Beating is done in a machine known as the "Hollander." The beating process requires twelve hours or more until all the fibers are separated. During the beating, coloring matter is added as well as chemicals to stiffen the sheet and make it nonabsorbent.

The man in charge of beating is highly skilled, for he must depend on his eyes and his sense of touch to determine when the beating is finished.



622 A Mechanical Grinder, courtesy of the Great Northern Paper Company, Boston

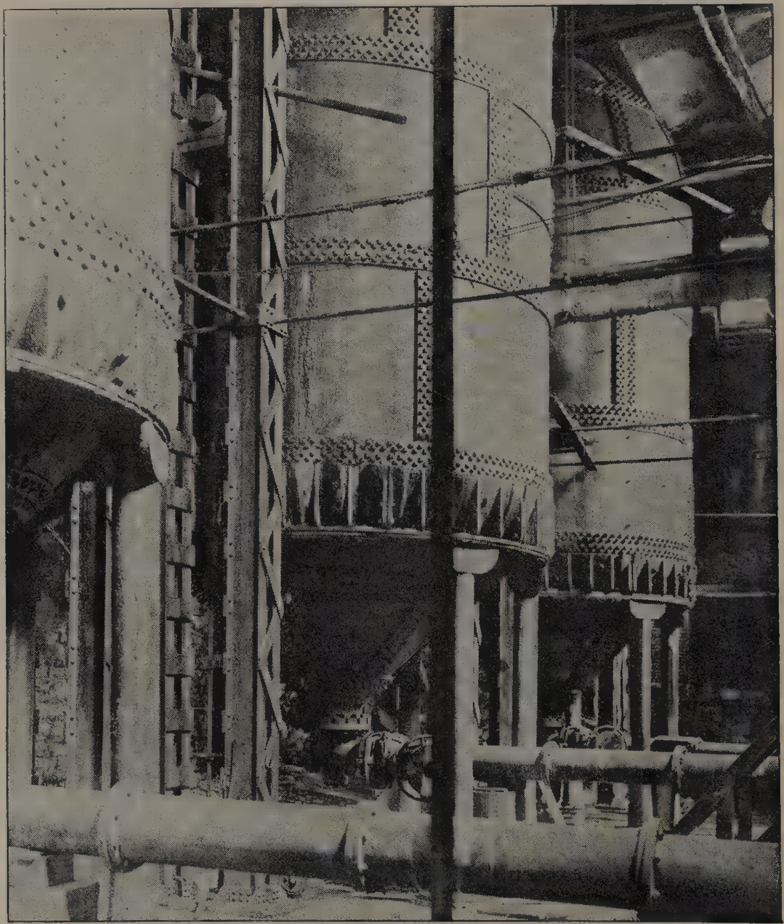
PREPARING WOOD PULP FOR THE "HOLLANDER"

Since most of our paper is manufactured from wood, the usual preliminary process before beating is the transformation of wood to wood pulp.

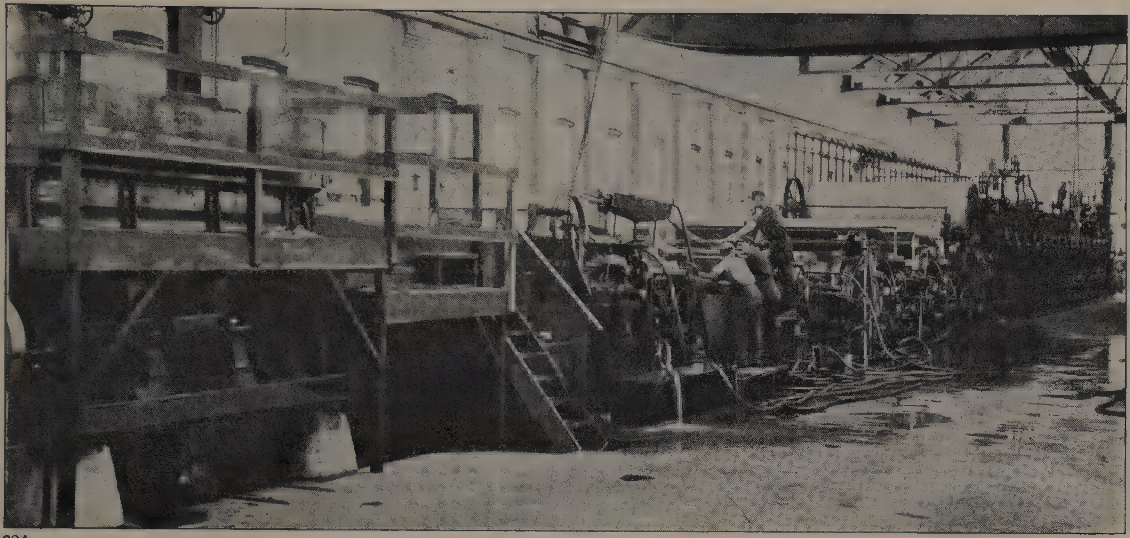
By the method of "mechanical grinding" the wood is entirely disintegrated by machinery without the use of chemicals.

Pulp made from ground wood is weak and produces an inferior paper. For better paper chemical pulp is mixed with the wood pulp. In making chemical pulp the wood is not ground but "digested" by chemical processes in huge vats sixty or more feet in height.

The digester selects only part of the wood it receives and discards the rest. As a result, chemical digestion is more expensive than mechanical grinding; only a relatively small part of the wood pulp in the beater is derived from the digester unless a high grade paper is desired. In that case the proportion of chemical pulp is increased.



623 A Chemical Digester, courtesy of the International Paper Company, New York



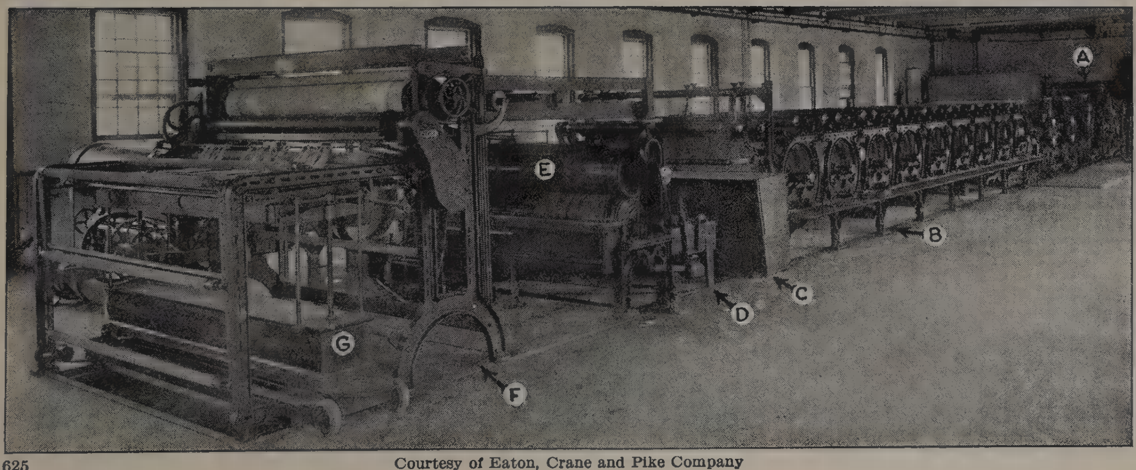
624 Courtesy of the International Paper Company

"WET END" OF A "FOURDRINIER" MACHINE

THE prepared pulp from the "Hollander" is run into a large reservoir from which it is pumped to the paper-making machine, or "Fourdrinier." The pulp flows on to a wire cloth to which is imparted the side motion or "shake" to weave the fibers together. The surplus water passes through the meshes of the wire, leaving the pulp to spread evenly on top. The sheet receives the impression of the watermark from what is called the "dandy roll," which is really a die affixed to a roll that in revolving impresses at regular intervals the mark in the pulp. The die thins the pulp where the impression is made, thus creating a means of identification of the paper.

"DRY END" OF A FOURDRINIER

THE traveling wire is shown at (A). After leaving the wire the paper is dried on an endless felt between a series of steam-heated rollers (B). Then it passes through the "slitters" (C), where the sheet is cut into the required widths. From here it passes through the sizing box (D), where a preparation imparts a film to both sides of the sheet, adding strength and making the paper impervious to writing fluids. After going through two more large rollers (E) called "calenders," that really iron the paper, it is then wound on a beam ready for sale. If the paper is to be cut into sheets it passes under a shear (F) after leaving the calender roll, and is piled upon an automatic table (G) which lowers itself as the pile grows. Paper requiring a special finish is further treated after passing the "calender rolls." Some of the best papers must be dried slowly for days in special rooms after passing the "calender" and when ready are "supercalendered," "plated," or treated in other ways to get the special finish desired.



625 Courtesy of Eaton, Crane and Pike Company

CHAPTER XII

PREPARING A NATION'S MEAT

THE typical householder in the American colonies raised his own meat and at the proper season salted or smoked it. In this way he insured his supply throughout the year. As cities grew up along the Atlantic coast, groups appeared who could not raise their meat and were compelled to buy it. The local butcher was their first meat packer. In his slaughterhouse the beef or pork was prepared to be sold either as fresh or preserved meat. As the city markets increased in size and the frontier pushed farther westward, a meat trade between the back-country and the coast towns sprang up. The frontier was well adapted to raising animals. In the first third of the nineteenth century it was a common sight to see herds of cattle and droves of swine making their way on foot to the markets of Baltimore, Philadelphia or New York, sometimes from as far west as Ohio.

Then the Ohio valley developed a meat-packing center of its own. The land of Ohio, Indiana, and Illinois proved to be well adapted to raising corn, and corn fed a steadily increasing number of swine. Cincinnati became a meat-packing center and retained its leadership until the Civil War. In its abattoirs the meat was salted and smoked to be shipped by river and canal to the southern and eastern markets. The day of refrigeration had not yet arrived.

After the Civil War the corn belt extended westward into Iowa, carrying with it the inevitable hog raising. Moreover, with the killing off of the bison and the pacification of the Plains Indians, the Great Plains which lie just east of the Rocky Mountains were turned into a vast cattle range. Though meat packing continued at Cincinnati, the location of that city was too far east to enable it to dominate the industry. Furthermore, Cincinnati had gained its fame principally as a packer of hog products, rather than of beef animals. Chicago, the meeting point of many railroads, and Omaha and Kansas City nearer the place of production, became the chief meat-packing centers of the postwar period.

But no longer was the meat smoked or salted. The railroad made quick transportation possible, and the development of refrigeration enabled the packer to sell his product fresh in the distant market. The rapid increase of urban population which was the result of the growth of industrialism gave the packer a swiftly expanding market. Meat packing passed out of the stage of small-scale production and became a large-scale enterprise. Competition was reduced as great meat-packing corporations were built up. Finally, the government of the United States, recognizing the importance of the industry to the health of the nation, established a strict supervision over the activities within the packing houses. With this final stage the development of the industry has become complete.

The packing industry has been notable as the first great American business to make an intricate use of by-products. This began with the pork packers at Cincinnati, who sold not only fresh and salt pork but bacon, lard, pickled pigs' feet and other delicacies. The great expansion of by-products was connected, both as cause and effect, with the consolidation and ramification of the packing industry at Chicago

626 William Pynchon, 1590-1662, from the portrait, 1657, by an unknown artist, in the Essex Institute, Salem

THE BEGINNINGS OF AMERICAN PACKING

The preserving of meat by drying, smoking, or pickling, was one of the first industrial occupations in colonial America. Besides what was done in the home, there gradually developed a market among the slave plantations and the trading fleets.

Much of the Connecticut River valley between 1650 and 1750 was the frontier of the New England colonies, and as such developed considerable reputation as a stock-raising region. The founder of Springfield, Massachusetts, William Pynchon, was a cattleman and a drover. As early as 1655 he began taking cattle on the hoof from Springfield to Boston, besides doing a considerable business in mutton, tallow, and wool. Pynchon is credited with being the first American to give his whole time to the business of meat packing, for which purpose he bought and packed hogs at Springfield. The market for his products was probably the West Indies.

THE BRIGHTON CATTLE MARKET

Boston became the great colonial market for live animals and meat. In 1633 the spot where the old State House stands was officially designated as a market place, and in 1742 Faneuil Hall became the gathering place for buyers and sellers. During or soon after the French and Indian War of 1756, Brighton sprang into prominence as a center for the cattle and meat trade, beginning with the activities of one butcher contractor, Jonathan Winship by name, who supplied the British army with meat.

During the Revolution, Brighton continued its interest in the business and soon after the war was over was the recognized market town in New England for cattle, hogs and sheep on the hoof, as well as for slaughtering and slaughterhouse products. The Brighton Market was a magnified town fair held weekly. The peaceful village was for a day densely thronged with herds, drovers and buyers. The trading done, Brighton reverted to its normal sleepy quiet. Brighton Market served as a model for many others, first in the east and afterward in the west; and Brighton itself continued to do a flourishing business until the growth of western packing houses killed most of its picturesque activities. To the present day, however, meat packing is one of its means of livelihood.

627 A Brighton Drover, from *Harper's Weekly*, Aug. 8, 1857

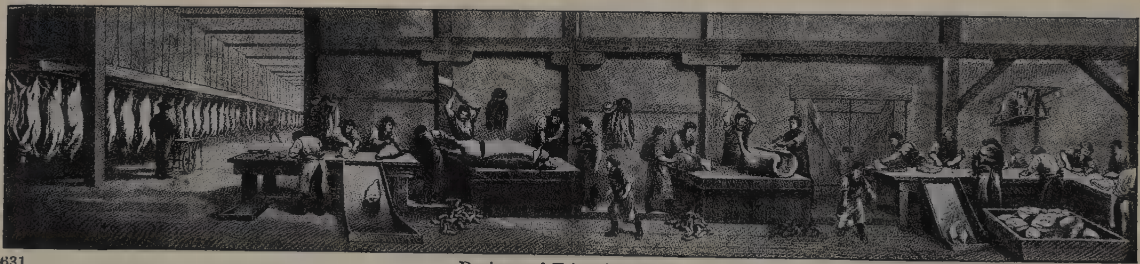
628 From John Warner Barber, *Historical Collections of Massachusetts*, Worcester, 1839

629 Driving Hogs Through the Streets, Cincinnati, from *Harper's Weekly*, Feb. 4, 1860

CINCINNATI, THE FIRST GREAT PACKING CENTER

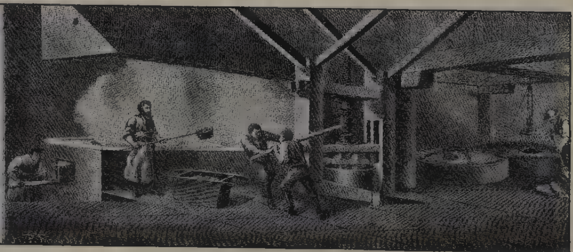
THE first great center of the packing industry in America was Cincinnati, "the Queen City of the West," for years the largest inland city in America, and at the time confidently expected by its inhabitants to become one of the greatest cities in the world. It was strategically located in the heart of the Mississippi valley, the unrivaled food-producing region of the United States; it was easily reached by water and stood at the crossroads of the principal highways of the country. With an excess of labor and well-developed financial resources, Cincinnati was an ideal place to establish this industry. Its first packers were farmers who, about 1811, in a small way prepared hog meat for local markets. The first regular hog packer was Elisha Mills, a "down-easterner," who started in 1818. By 1830 Cincinnati was so famous for its hog products that it was called "Porkopolis." In 1832 some 85,000 hogs were slaughtered there and by 1860 about half a million were going under the knife. The hogs arrived at Cincinnati on the hoof, by flatboat, steamboat, and eventually by train. They were driven through the streets to the slaughterhouses by drovers, men and boys. The carcasses were carried by wagon to the packing houses; for at Cincinnati slaughter and packing were separate industries. Until 1857, Cincinnati's activities in pork were entirely confined to the winter season, but thereafter the work was prosecuted the entire year.

630 Slaughtering and Dressing Hogs



631 Drying and Trimming Hogs

632 The Curing Cellar



633 The Lard-Rendering Room

Pictures (630-633) are scenes of Hog Packing at Cincinnati, from *Harper's Weekly*, Sept. 4, 1873, after drawings by H. F. Farny

634 The Sherman Yards, 1861, courtesy of Swift & Company, Chicago

THE EARLY PACKING INDUSTRY IN CHICAGO

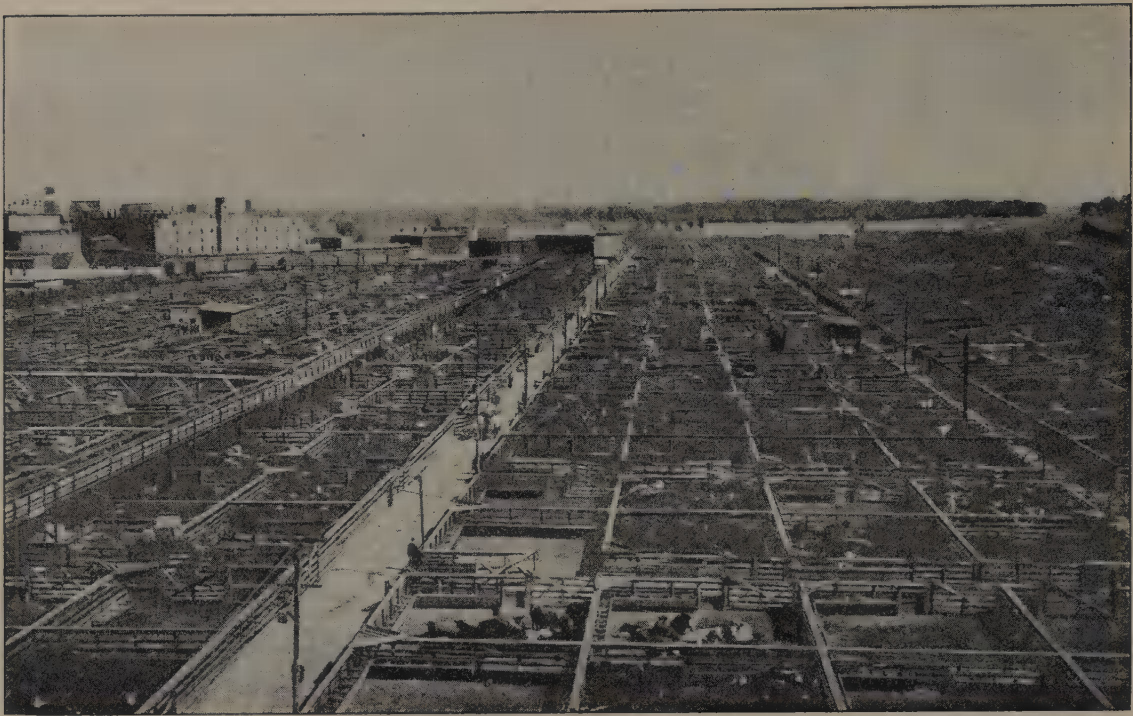
SINCE the prestige of Cincinnati was in great part due to its advantages in respect to water transportation, the coming of the railroads brought significant changes. Chicago was the halfway point between western animal producers and eastern meat consumers. As the largest railroad center in the world it posessed unrivaled transportation facilities; in addition it had the Great Lakes as a competitor and regulator of the railroads. The first slaughterhouse in Chicago was established by Archibald Clybourne in 1827 and the first packer began operations five years later. It was not until the late 'fifties, however, that Chicago began to forge ahead, and soon after the enormous demands for foodstuffs occasioned by the Civil War consolidated Chicago's position. In 1862 Chicago surpassed Cincinnati and since 1870 the city on Lake Michigan has had no equal as a packing center.

The first extensive stockyards in Chicago, erected at Madison Street and Ashland Avenue, dated from 1848 and were called the Bull's Head Market. Since this market had no railway connection it was abandoned after 1856, when John B. Sherman purchased the Myrick property of thirty acres, located on the lake shore and tapped by the Michigan Central and Illinois Central Railroads. The Sherman yards, however, soon had several rivals equally well located in respect to railroad facilities.

THE OPENING OF THE UNION STOCKYARDS, 1865

THE pressure of business occasioned by the Civil War threw into high relief the difficulties arising from the system of many separate yards, and in 1865 the Illinois legislature granted a charter of incorporation to the Union Stockyard and Transit Company. The stock of this corporation was subscribed by nine railroads and many private individuals, but the railroads took ninety per cent of the million dollars issued. The yards, comprising three hundred and forty-five acres and a pen capacity for twenty-one thousand cattle, seventy-five thousand hogs, twenty-two thousand sheep and two hundred horses, were opened for business on Christmas day, 1865. Since that time the area of the yards has been greatly increased; at the present time some two thousand men are employed and the yards contain about three hundred miles of railway trackage.

635 The Union Stockyards in 1868, from a sketch, courtesy of Armour and Company, Chicago



636 © Kaufman & Fabry, Chicago

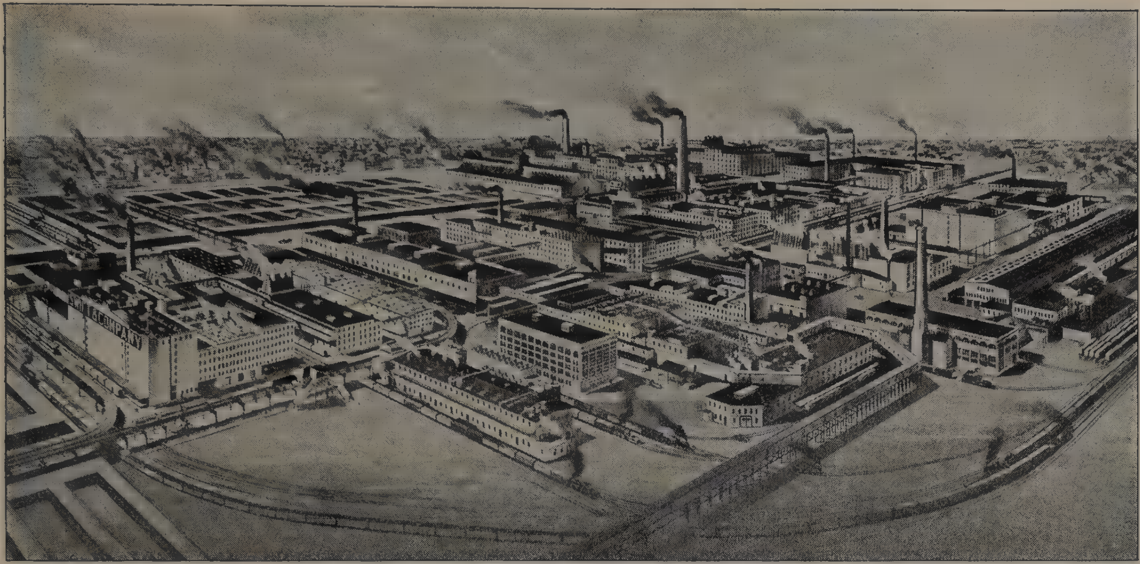
A VIEW OF THE CHICAGO STOCKYARDS

THE immense area of the Union yards at Chicago, the great covered sheds, the packing plants in the background, the trampling of hoofs, the bellowing and lowing of the animals, the riders dashing about the streets between the pens, the dust and smoke make a visit to the stockyards an experience not quickly forgotten.

UNLOADING HOGS AT CHICAGO

TRAINLOADS of animals in cars especially designed for the traffic are continuously shunted into the stockyards. The animals are disembarked into the pens. There they are looked over by the buyers on horseback representing the packers. The seller is generally a Chicago commission man to whom the animals have been consigned by the farmers. When a sale price has been agreed upon the animals are weighed and driven to the near-by plant of the purchasing packer.

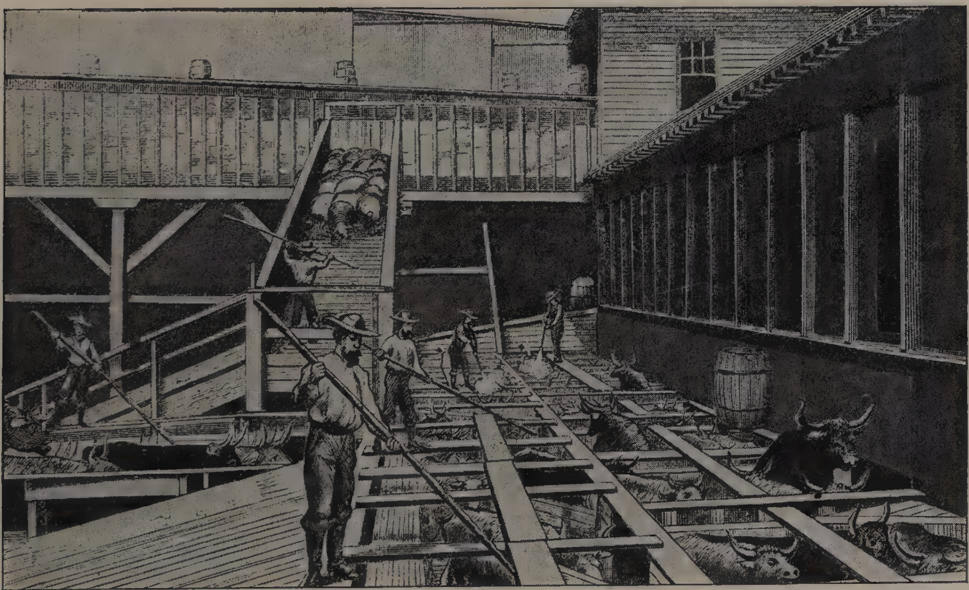
637 Courtesy of Swift & Company



638 Courtesy of Swift & Company

A CHICAGO PACKING PLANT

THE packing plant of to-day, located near the stockyards, is a mammoth enterprise. Unlike the early Cincinnati organization, the modern business at Chicago is a combination of slaughterhouse and packing plant. There is no waste in the business; every part of every animal has some use. To manufacture these waste materials necessitates many additions to the facilities besides those used in connection with the principal business of killing and packing. The packages for both the main products and the by-products may also be made on the spot.



639 From Joseph G. McCoy, *Historic Sketches of the Cattle Trade of the West and Southwest*, Kansas City, Mo., 1874

THE OLD METHOD OF SLAUGHTERING CATTLE

THE old method of slaughtering cattle, a heritage from the American frontier, was to shoot them in the pens from narrow gangways above their heads. The usual modern method of slaughter is to stun the steer with an especially shaped mallet, and then sever its jugular vein with a knife. Hogs are not stunned; a chain is attached to a hind leg while the other end of the chain runs over a wheel and thence to an overhead rail. The hog thus hanging head downward passes quickly before a man who slits its throat.

640 From a photograph by the United States Department of Agriculture

MODERN DRESSING OF CARCASSES

THE carcasses pass by an overhead rail to the butchers, each one of whom has one special part to cut. Thus the animal is divided and subdivided into the commercial parts that his carcass may be capable of producing. The waste materials are cut away in the passage through the plant and sent to the appropriate place in the works.

GOVERNMENT INSPECTION OF MEAT

SINCE the public would be endangered by diseased or otherwise unfit meat it is essential that there be public inspection and supervision of the packing industry. This inspection is under the control of the federal government and begins with the live animals in the stockyard pens. At every stage of the slaughtering and packing operations the government inspector stands beside the packing house employee. Immediately after the killing the inspectors examine the glands of the head and throat of the animal, for these glands give the first and best evidence of the animal's condition. Later the viscera are looked over carefully by the inspector, and each part of the animal as it is subdivided is given an equally careful inspection. By means of marks it is possible to identify every animal even after it has been cut into the smallest parts. The preparation of the various parts and even the packaging of the parts ready for sale are under the eye of the federal supervisors. These men are not permitted to accept any gift whatsoever from the packer and are shifted from plant to plant at frequent intervals. The inspector's word is law.

The packers do not object to the rigid inspection because it enhances public confidence and is an aid in selling, particularly in foreign markets.

641 From a photograph by the United States Department of Agriculture

THE REFRIGERATOR CAR

642 Courtesy of the New York Central Lines

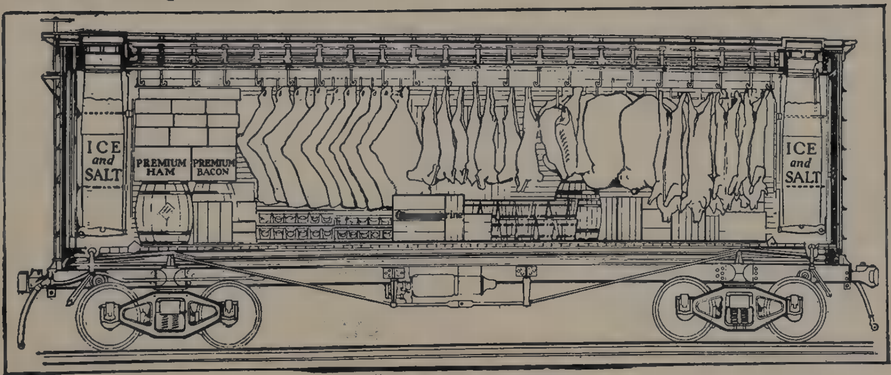
For a long time all meat packing was done in the winter, but the development of artificial refrigeration eventually made it possible to pack all the year round. Nothing did more to regularize the cattle and packing industries. But even when this step had been taken it was still necessary to drive or ship live animals to distant markets for slaughter and packing. The packers toyed with the idea of a refrigerator car for some years before a practical car was invented.

The importance of the refrigerator car cannot be exaggerated. Its economy is manifold. It saves the wastage of flesh inherent in the long distance shipment of live animals, it permits packing plants near the source of animals, it allows for large-scale packing enterprises, and it provides a means for keeping fresh meat in prime and healthy condition regardless of time or distance. The modern organization of both the cattle industry and the packing business would be impossible without the refrigerator car.

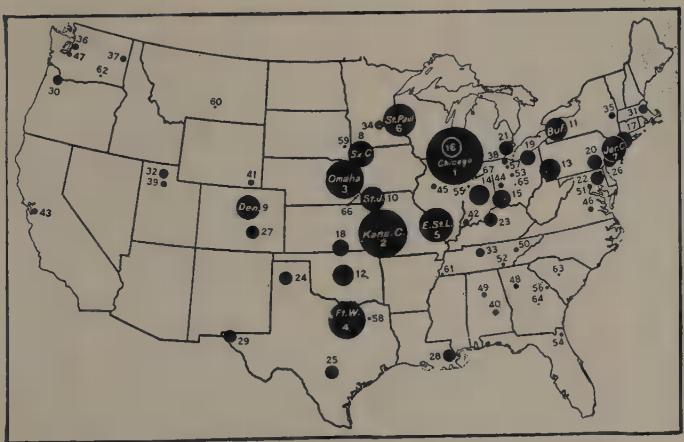
HOW PRODUCTS ARE SHIPPED IN A REFRIGERATOR CAR

The refrigerator car has an ice box at each end. These are replenished en route from the top and from the outside of the car without disturbing the contents. The car is arranged so that the cold air from the refrigerators passes in currents over and around the cargo. Those products that need the greatest cold are located nearest the ice containers, while those that require less or might be injured by too much cold are hung in the middle of the car.

The packers themselves for the most part own the refrigerator cars. The packers pay the regular railway freight charge but the railroads return to the packers a mileage rental for the use of the cars. The railroads, particularly when refrigerator cars were a new venture, could not afford to buy such specialized equipment.



643 Courtesy of Swift & Company



644 From the 1921 *Yearbook* of the United States Department of Agriculture

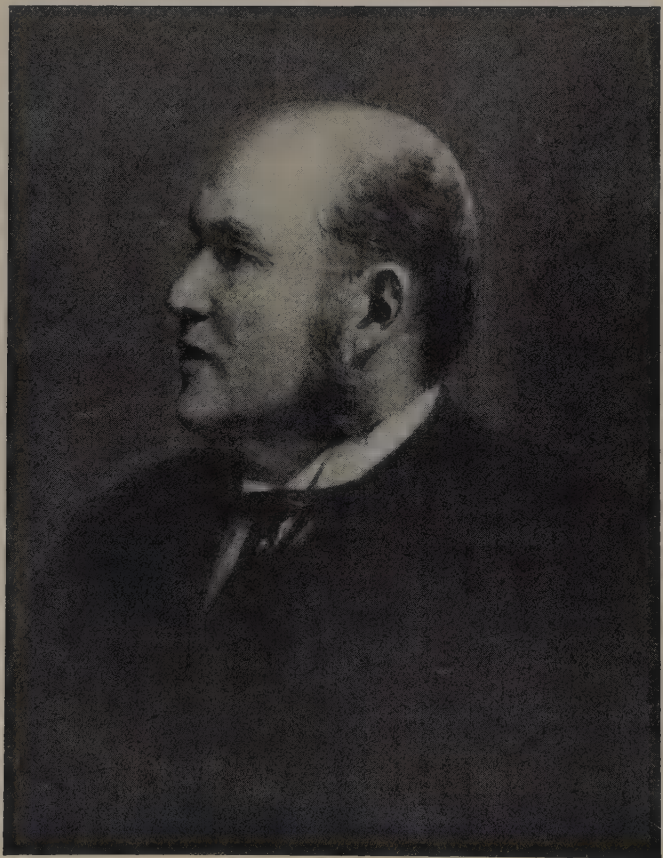
RELATIVE SIZES OF AMERICAN CATTLE MARKETS

Chicago, although the greatest, is by no means the only slaughtering and packing house center. The tendency has always been to get these two industries as near as possible to the point of origin of the cattle. Hence St. Louis, Kansas City and Omaha each have an important stockyard and packing business. Denver likewise has a smaller enterprise to take care of the Rocky Mountain district and the Pacific coast states have their own smaller plants. In the great cities of the East, too, there are slaughterhouses and packing plants.

645 Armour's Kansas City Plant *ca.* 1870, from Joseph G. McCoy, *Historic Sketches of the Cattle Trade*, etc.

PHILIP D. ARMOUR, 1832–1901, A GREAT AMERICAN PACKER

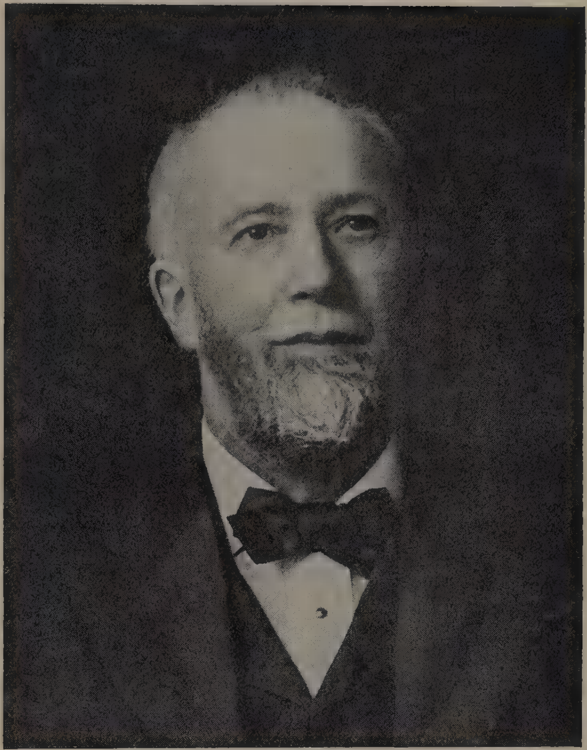
AMONG the dozen or more men whose names are intimately connected with the rise of the modern packing industry none is more familiar than that of Philip Danforth Armour. Born on a farm near Stockbridge, New York, Armour, a young man of twenty, reached California after a journey of six months on foot. But he did not dig for gold; he dug ditches for other diggers of gold, a less romantic but still profitable work, for in five years Armour made eight thousand dollars at it. Later he went to Milwaukee, which at that time seemed likely to be a more important city than Chicago. In 1859 Armour went into the grain produce and commission business at Milwaukee. Four years later he was taken into partnership by John Plankinton, then a thriving merchant and commission man in Milwaukee. Plankinton and Armour soon had one of the largest slaughtering and packing plants in Milwaukee and established branches in Chicago and Kansas City. The Civil War put the firm on a secure financial basis.



646 From the portrait of Philip D. Armour by Arvid Nyholm (1866–) in the possession of Armour and Company, Chicago

Armour brought his various brothers into his business, placing them at strategic points such as New York, Chicago and Kansas City. After the Union Stockyards were built at Chicago, Armour built a hog packing plant there and later added cattle. He was a prime mover in the development and use of refrigeration and the refrigerator car. The firm became Armour and Company when the Chicago plant was opened and soon developed into one of the most far-reaching enterprises of its time. At the present day Armour and Company is one of the three or four great firms that together control the largest part of the American packing industry. It is a monument to the sagacity, foresight and business enterprise of the founder, one of the most notable men of his day.

GUSTAVUS F. SWIFT, 1832–1903, A PIONEER OF MODERN PACKING



647 From a photograph taken in 1901, courtesy of Swift & Company

ANOTHER Easterner, Gustavus Franklin Swift, is associated with the rise of the modern packing industry. Born in West Sandwich, Cape Cod, Swift was the ninth child and fifth son in a family of twelve children. At fourteen he became a butcher's apprentice and carried on his trade and also that of a cattle dealer in several Massachusetts towns. In 1872 Swift entered into partnership with Henry Hathaway, in which firm Swift became the cattle buyer. Convinced that Chicago would become the leading cattle market, Swift moved there in 1875 and was a buyer at the Union Stockyards. Soon, however, he bought a slaughterhouse and packing business and set out on the career that brought him fame. Swift was one of the first men to send dressed meat from Chicago to the eastern market and his eastern connections aided him greatly in this venture. Swift was one of the few men who made the refrigerator car a commercial success. The firm Swift & Company was incorporated in 1885. Starting with a capital of three hundred thousand dollars, within two years it was advanced to three million and later reached one hundred and fifty million. Swift was a dreamer, but his dreams were always practical; he was an inventor, but his inventions were based upon an existing need; he was a financier with an uncanny ability to gauge the future; but most of all Swift was an organizer. He had the ability to make his personality penetrate to the smallest section of his ever expanding business; this was the real basis for his success.

648 The First Swift Slaughterhouse, Barnstable, Massachusetts, courtesy of Swift & Company

CHAPTER XIII

TANNER AND SHOEMAKER

THE time when men first learned to turn skins and hides into leather is shrouded in the obscurity that lies beyond the dawn of history. We know that leather was one of the earliest and also one of the most universal additions to man's equipment. For suitable raw materials men have explored the animal, vegetable, and mineral kingdoms. The hide of elephant and buffalo, the pelts of antelope, deer, kangaroo, and rabbits, the skins of seals, sharks, porpoises, walruses, whales, lizards, crocodiles, alligators, snakes, and frogs, all these have at times and in places contributed supplies to the tanner's art. Nor have the birds escaped, for the skins of ostriches, swans, and chickens have been made into leather. Man's own skin has been used for the same purpose.

For tanning agents, the brains, oils, and fats of animals have been used; the woods, barks, leaves, fruits, roots, and even the larvæ of parasitic insects or the diseased portions of plants have been made to yield materials for converting skins into leather. From reptiles to man, from roots to fruits, nearly every living thing sometime or somewhere has been made to fill the need for leather. From savagery to civilization, leather has been a most popular material for man, and he has used it for clothing, houses, house furnishings, tools, weapons, and musical instruments. Man's history has been written on leather or bound in leather. One of man's oldest and most widely distributed arts, leather manufacture, has been always essentially the same. Civilization has developed machinery for some of the harder operations, but the processes have altered but little.

In the history of the American people the tanning of skins has been associated with two important industries, fur trading and stock raising. From the beginning of settlement to the passing of the frontier, the fur trade was an important factor in American life. Nor has the twentieth century seen its entire disappearance. The Indians and trappers bringing the pelts of the forest animals to the settlements have furnished work for the tanner who prepared them to be turned to the uses of civilization.

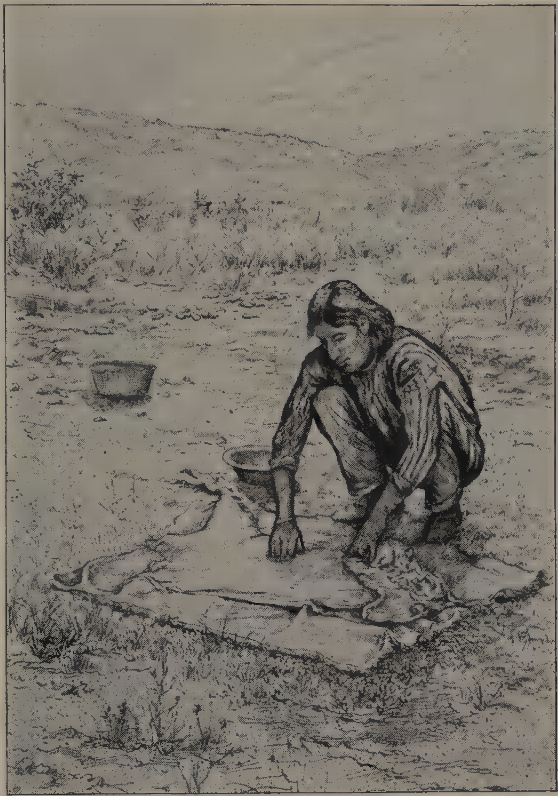
The most important source of the skins which come to the tannery is the cattle industry. Buffalo skins were extensively tanned during the decade after the Civil War when the vast herds were being wiped out by ruthless hunting. The rise of the cow country on the old grazing ground of the bison vastly increased the supply of hides for leather. The cow country sprang into existence as soon as transportation had made it accessible to the eastern centers of population and in answer to the demand for meat by a rapidly increasing population. Shoes were needed as well as meat and the western cattle ranches supplied hides as well as food. But the making of shoes did not at first gravitate to a region near the present source of the raw product.

Leather can be transported at such a relatively small expense that the shoe manufacturer is free to locate his factory to meet the needs of other phases of his business. Naturally shoe manufacturing made an early appearance in New England, where most of the earliest American factories had been founded, where water power was plentiful and where there were supplies of skilled labor. Once established in New England there were at first no forces as strong as those in the cotton industry to pull the factories to other sections. Plants for making boots and shoes have appeared in many places but the center of the industry still remains New England, although it may not long be able to make this boast.

INDIAN TANNING

The early Egyptians slew gazelles and oxen and from the hides made leather. The tools for doing these tasks were almost identical with some of those used by the American colonists.

American Indians, too, were skilled leather workers. A common practice among the Indians was to kill a deer and remove the hair from the skin. The latter was then tanned by the use of the deer's own brains. When the deerskin had been converted into leather by the rubbing of brains into the pores of the skin, the leather was softened by stretching and working the surface by hand.



649 Applying Brains to Soften a Skin, from the *Report* of the United States National Museum for the year 1889, after a photograph by Robert Wilson Shufeldt

650 Stretching a Deerskin, from the *Report* of the United States National Museum for the year 1889, after a photograph by Robert Wilson Shufeldt

THE FIRST AMERICAN TANNERY

Tanning was one of the most common arts practiced by colonial Americans. At first it was a household industry, but since it required skill it was one of the first given over to specialists.

It is believed that the earliest tannery to operate as a business, separate from the household, was started in 1630 at Lynn, Massachusetts, by Francis Ingalls. This tannery resembled scores of others later set up in frontier settlements as pioneers migrated across the continent.

These primitive tanneries were pits dug in the ground, on the bottom of which was spread a layer of bark, then a layer of skins, and so on until the pit was filled. Water was then poured over the whole, leaching the tannic acid from the bark and carrying it to the pores of the skins. From time to time the tanner turned the skins over so that each should get an even action from the solution in the pit. It took about a year for a skin to absorb enough tannic acid to be converted into leather, and if the tanner were not skilled in handling and leaching the skins in the pit, the whole might be spoiled. He used no chemical tests, although his was really a chemical industry. Instead, he relied upon the look and feel both of the hides and the tan liquor to guide him.

651 The Ingalls Tannery, Lynn, 1630, from a sketch based on available data, courtesy of Fred Gannon, Salem, Mass.

652 From a photograph in the collection of the Essex Institute

AN OLD-TIME OPEN-AIR TANNERY

ANOTHER pit tannery at Salem shows the same primitive conditions that obtained at the first Lynn tannery. Three hundred years have shown in America almost no progress in the art of tanning.

MODERN TANNING BUILDINGS

THE tan pit, out of doors, is now discarded except in a few remote places, and tanning is as completely housed as any other manufacturing industry. Modern tanneries are both on a small and on a large scale. Small tanneries are scattered in many places in the United States.

653 Courtesy of the Tanners' Council of America, New York

THE SOAKING PIT

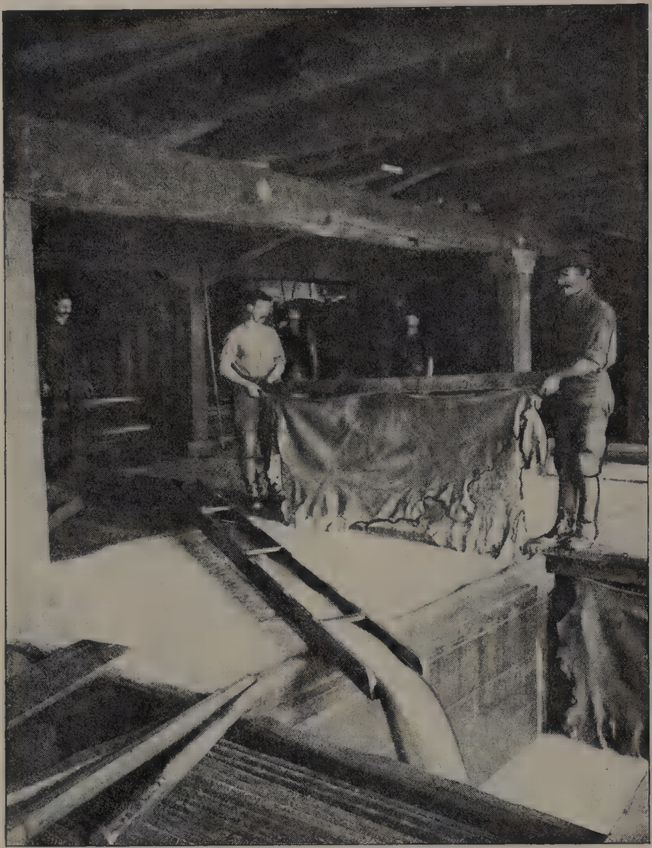
654 Courtesy of the Tanners' Council of America

The manufacture of leather falls naturally into three parts. The first is the beam-house work, where the hides and skins are prepared for the actual tanning. The second is that in which the hides are converted into leather. The third process, once the separate craft of currying, consists in finishing the tanned leather according to the uses for which it is intended. Hides are collected from all over the world and arrive at the tannery in stiff dry bales, or wet and sloppy from pickling preservatives, or covered with fresh blood and dirt if sent directly from the slaughterhouse. The first step in the beam-house operation is to give the hides a thorough soaking to make them pliable, and to remove surface dirt. Similar pits containing mixtures of water and lime, or other materials, are employed to loosen the hair, or to soften very dry and tough hides.

SPLITTING HIDES BY MACHINE

When the hides have been washed and the hair loosened, they are then taken one by one from the pits, to be dehaired and defleshed. The hair is scraped off by a knife worked over a rounded beam, or removed by a machine. It is then sold to mattress manufacturers or other users of hair. The loose flesh and blood vessels are scraped off and sold as fertilizer. The hides are next split if they are too thick. This splitting used to be done wastefully by hand. It is now done by a delicately adjusted machine. Thus a single cowhide may be split into two or more hides. Each split has a trade name, and the resultant leather is designated as a whole hide, the split next the hair, or the split next the flesh. The splitting of hides is of great economic importance now that the cattle ranches are dwindling.

655 © Ewing Galloway



656 © Keystone View Company

THE TAN VATS

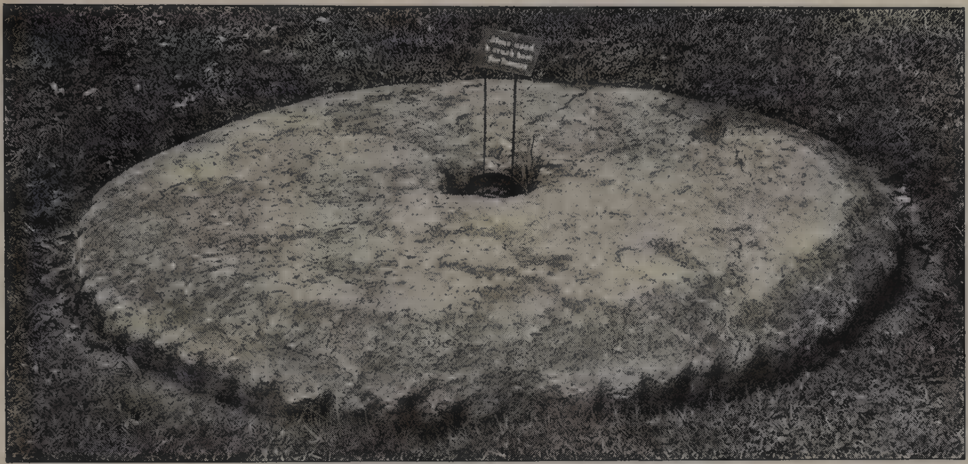
Before tanning commences the whole or split hides must be cleaned of all the substances used in dehairing, defleshing, or softening. To do this they are put in vats to be "pured." The puring process completes the beam-house work and the hides are now ready for the actual tanning. Tanning pits have disappeared. The modern tannery performs the tanning operation in vats or great tubs, filled with tanning liquid into which the green hides are dumped. The hides are stirred to ensure an even effect from the tanning liquor. The vats are placed in a series beginning with one containing weak liquor and ending with fresh strong tanning solution, the hides being removed from one vat to the next at the proper time. The action of the tannic acid on the fibers and gelatin content of the hide effects the change into leather.

POLISHING LEATHER WITH A STAKING MACHINE

When the tanning is completed the leather is tacked to boards or hung over racks and when sufficiently dry is ready for currying, the third process in its manufacture. Currying varies according to the intended use of the leather. Flexible leather pocketbooks and durable leather soles call for different treatment. In general, we may say that leather is filled and worked with oils and other solutions to give pliability. It is painted and polished to give it glaze and may be dyed to give it color.

The staking machine polishes leather by means of a glass roller passed under pressure over the leather.

657 Courtesy of the Tanners' Council of America



658 Old Stone to Crush Bark for Tanners, in the Essex Institute

THE USE OF BARK AS A TANNING AGENT

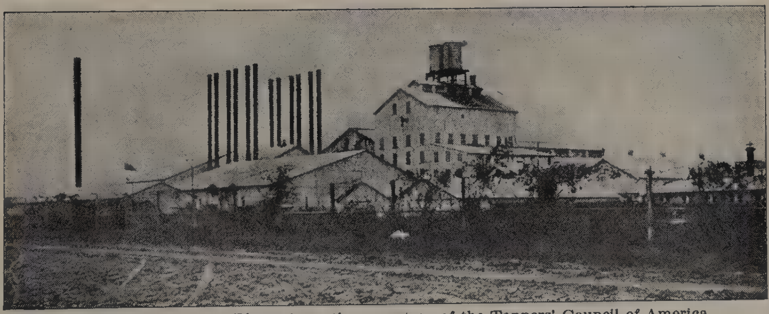
A WIDE variety of tanning agents has been employed to convert hides into leather. The most common, however, has been the bark of certain trees, notably oak and chestnut and hemlock. Although bark is relatively light in weight, it is bulky and fragile, and its tannic acid content is easily leeched away if the bark is exposed to the rain. Bark therefore has never been transported very far from the forests. Hides, on the other hand, may be carried around the world without undue deterioration, and their value is great enough to pay high carriage charges. Hence tanneries were generally located near forests. As the forest regions were altered by excessive cutting the tannery moved with the loggers. New England, Pennsylvania, New York and the southern Appalachians have each in turn witnessed a large tanning industry.

659 Transporting Quebracho Logs, South America, courtesy of the Tanners' Council of America

Millstones similar to those used for grist were employed by the colonial tanners to crush the bark preparatory to use in the tan pit. The modern bark grinder is a set of metal rolls entirely inclosed and arranged for rapid feeding and delivery.

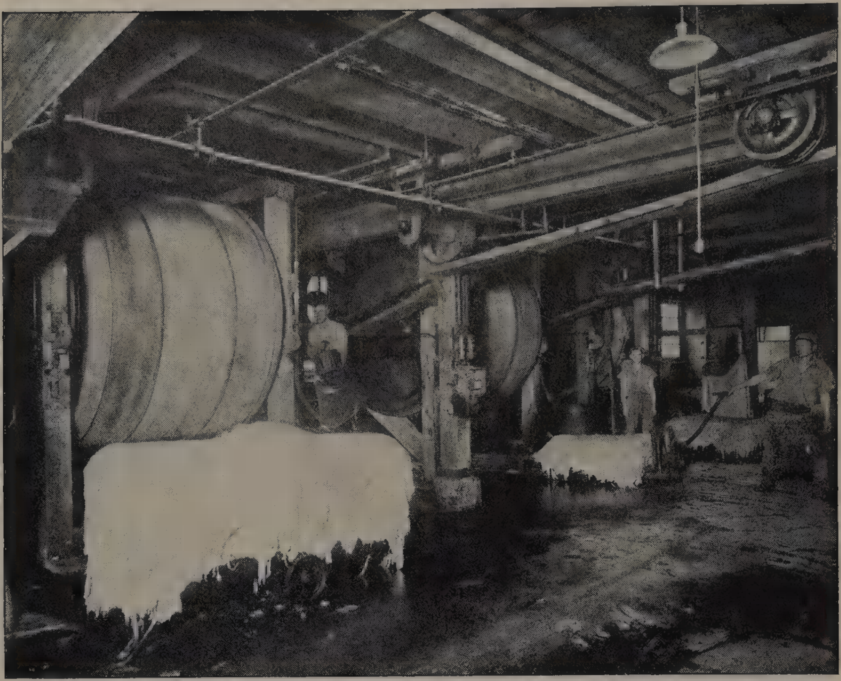
QUEBRACHO BARK

WITH the development of large-scale slaughterhouses at Chicago and other places, large numbers of hides for the first time were to be had at one place. The use of tannic acid extract permitted the tanning of hides on the spot, and produced better leather because it was easier to standardize and control extracted bark liquors than it had been to control the tanning under the older methods. A ring of tanneries in Illinois, Michigan, and Wisconsin surrounded the Chicago slaughterhouses.



660 A Quebracho Extract Plant, Argentina, courtesy of the Tanners' Council of America

With the decline of American tan bark resources, our tanners turned to the Argentine, where the quebracho tree yields a large proportion of tannic acid. Although quebracho bark may be imported to this country it is generally shipped here in the form of extract.



661 Tanning Drums for Chrome Leather, courtesy of the Ohio Leather Company, Girard, Ohio

CHEMICAL TANNING

AMERICAN ingenuity did not stop with the invention of tanning extracts. Chemists have found that good leather may be made from various mineral compounds, notably chromium. Robert H. Foerderer of Philadelphia conquered the difficulties that beset chemical tanning and was the first to manufacture and market successfully leather made by that means. After Foerderer in 1888 pointed the way, mineral tanning became immediately popular. It furnished most of our light leathers and drove out of our market similar imported products made in older ways.

Chemical tanning differs from bark tanning not in methods or machinery, but in the materials used for changing skins into leather. Practically the only unique machine used in chemical tanning is the large revolving drum in which the actual conversion takes place.

At first chemical tanning was applied mainly for the uppers of shoes or other light leathers, but of late the method has been adopted for some heavy leathers such as that for shoe soles. This betokens the passing of bark tanning and marks a new era in the leather industry.

THE OLD-TIME SHOEMAKER

THE greatest user of leather is the shoemaker. A peculiar human interest has been associated with shoemaking from the arrival of Thomas Beard and Isaac Rickerman in Salem, Massasetts, in 1629, down to the latest recruit in a modern factory. Since shoemaking was a sedentary, noiseless, well-nigh mechanical task, it gave to the craftsman opportunity to think and talk about politics, religion or philosophy. It is understandable, therefore, why shoemakers' shops were often looked upon as clearing houses of opinion and why shoemakers have frequently risen to exalted places. In our own history two signers of the Declaration of Independence were shoemakers. Likewise Mad Anthony Wayne, the Revolutionary general whose brilliant exploits astonished both his friends and his enemies, was a shoe craftsman. A long list might be compiled of shoemakers who became famous.

662 "Whipping the Cat," from *Harper's New Monthly Magazine*, Jan., 1885

Manual skill being the stock in trade of the shoemaker, and his tools being few, light, and easily portable, the trade could be practiced wherever the artisan happened to be. With lapstone, shoulder stick, hammer, awl and waxed thread he wandered from home to home offering his services. Shoemakers called this "whipping the cat," and in pleasant weather often worked in the farm dooryard.

THE "TEN-FOOTER"

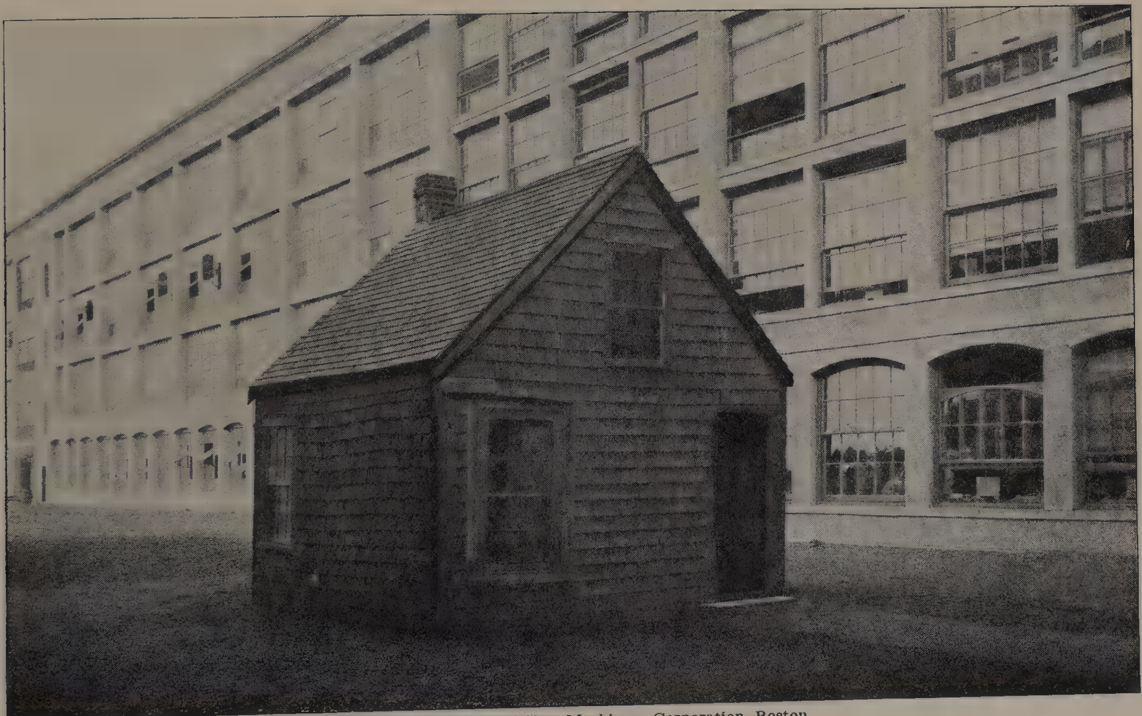
John Adams Dagys, a Welsh immigrant settling in Lynn in 1750, was responsible for converting shoemaking into a centralized business. Under his scheme, men cut out the parts of a shoe in a little ten-foot shop and sent the uppers out into homes where women "bound" them together. Upon return to the shop, men sewed the uppers to the soles, and shaped and finished the shoes.

Lynn soon had many of these little shops, and by 1795 claimed two hundred master workmen, six hundred journeymen and a yearly output of three hundred thousand pairs of shoes. Lynn, following Dagys' lead, specialized in women's shoes. After the Revolution, the region near Brockton became equally famous for the manufacture of men's shoes, some of the citizens of the locality having learned the trade in British prisons during the war. Lynn and Brockton have ever since shared the leadership in American shoe manufacture.

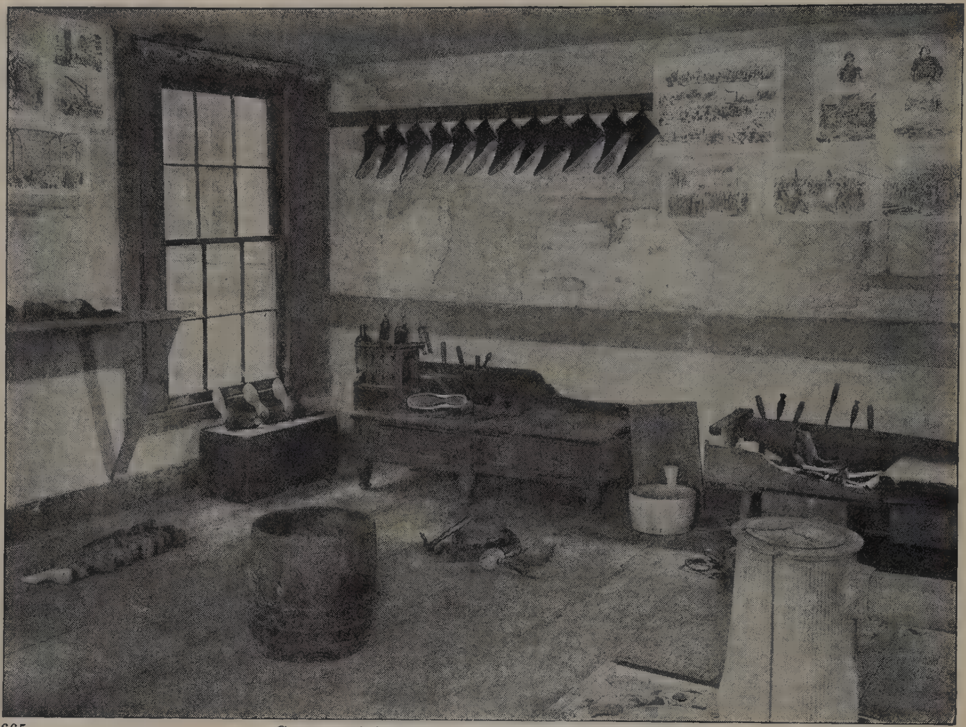
663 From David N. Johnson, *Sketches of Lynn*, 1880

THE OLD AND THE NEW

The old Winslow shop at Lynn, Massachusetts, one of the "ten-footers," has been preserved to the present day. It is surrounded by the great structures in which modern factory processes are carried on.



664 Courtesy of the United Shoe Machinery Corporation, Boston



665 Courtesy of the United Shoe Machinery Corporation

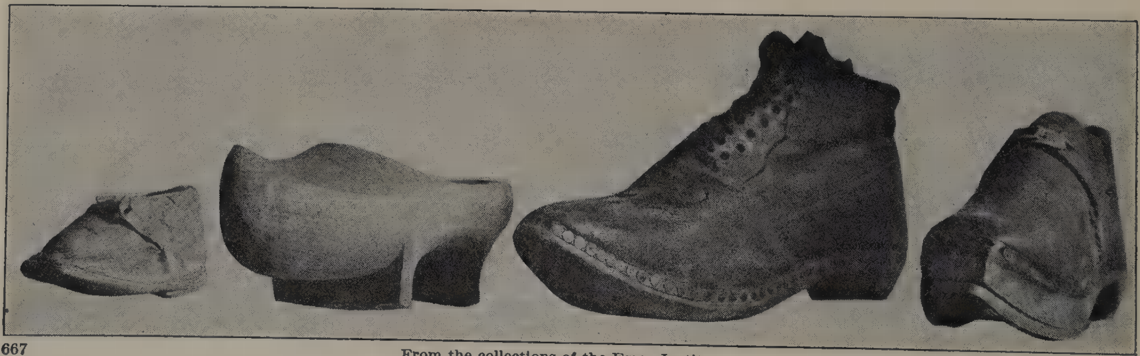
INTERIOR OF THE OLD WINSLOW "TEN-FOOTER"

THE old Winslow shop was recently refitted with the old-fashioned equipment used about 1860 when the shop was last in operation. A group of old-time shoemakers were then brought to the shop and set to work making shoes as they would have done in the old days. One night they went away and did not return, leaving the shop exactly as it appeared when last occupied in the early 'sixties.

666 From the collections of the Essex Institute

TYPES OF OLD-TIME SHOES

THE evolution of the leather shoe starts with the moccasin and the brogan. Wooden shoes were also made. The latter were by no means limited to Dutch settlements. Wooden soles for leather shoes are also common now in many parts of Europe. In America they are manufactured mainly for special industries where it is necessary to keep the feet dry, and are used largely in dye houses and around chemical vats.



667 From the collections of the Essex Institute

A PAIR OF HANDMADE BOOTS, 1813

DESPITE the localization of the shoe business in the "ten-footers" of Lynn, Brockton and neighboring towns, shoemaking remained a hand trade until the middle of the nineteenth century, but the shoe craftsmen long since gave up trying to make each pair of shoes fit a particular individual. A standardized product appeared long before the shoe machine.

668 From the collections of the Pocumtuck Valley Memorial Association, Deerfield, Mass.

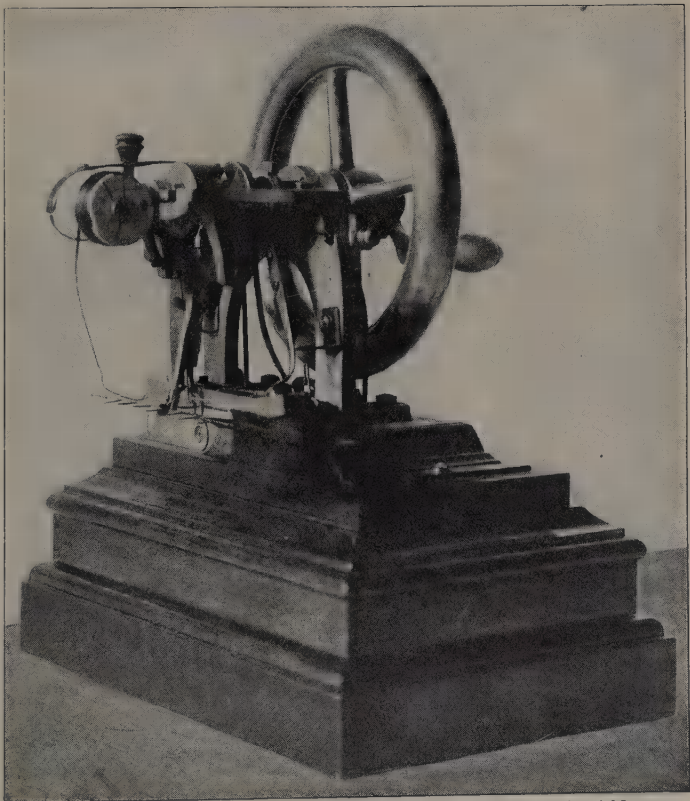
669 Shoe Pegged by Samuel Preston, 1833, from the collections of the Essex Institute

THE INVENTION OF THE PEGGING MACHINE

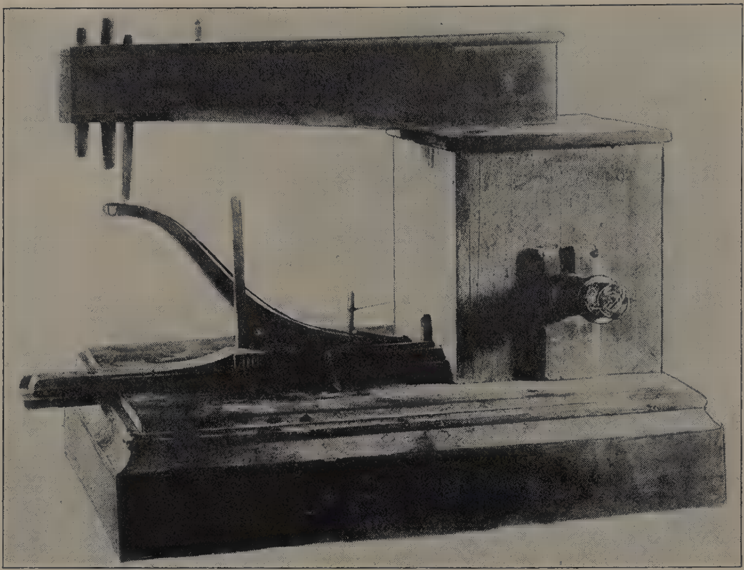
As long ago as the 16th century, wooden pegs were used to fasten heels to shoes, but it was not until about 1800 that hand whittled wooden pegs were used to join the upper with the sole. A machine for making pegs was invented in 1815 and in 1833 another machine was introduced by Samuel Preston for performing the pegging operation. The latter, however, did not come into widespread successful use until about 1857. Besides pegs, iron or copper nails or screws were often employed. Pegged shoes being stiff were seldom worn on dress occasions, but for working purposes they are still made and sold.

THE INTRODUCTION OF SEWING MACHINERY

THE first machine, introduced in 1845 and adopted extensively by shoemakers, was one which rolled sole leather, instead of hammering it, to make the sole hard, compact and durable. The next mechanical advance was the adapting, in 1851, of Elias Howe's sewing machine for work on uppers, which brought this process under the same roof as the other shoemaking operations. The various forms of shoe-sewing machinery that have developed from Howe's original machine are also mainly the product of American inventive genius. The modern shoe factory, in the parts devoted to making the uppers of shoes, contains scores of sewing machines that differ but in details from those used by the housewife for general purposes.



670 Howe's Sewing Machine, from the original in the United States National Museum



671 From the original machine in the factory of the United Shoe Machinery Corporation, Beverly, Mass.

BLAKE'S SEWING MACHINE, 1858

LYMAN R. BLAKE in 1858 invented a sewing machine to replace hand work in sewing soles to uppers. He turned his invention over to Gordon McKay, a capitalist and manufacturer of Pittsfield, Massachusetts. McKay not only improved the machine but was responsible for promoting it and getting it accepted by the shoemakers. As a consequence Blake's name is seldom associated with the machine of which he was the inventor.

The first firm to use a Blake-McKay machine was William Porter and Sons of Lynn, who set up the device in their shop in 1861, an example which was soon followed by other manufacturers of cheap shoes, for from the first the machines turned out thirty times as much work per day as a man.

GOODYEAR-WELT SEWING MACHINE

THE McKay sewing machine produced work that had one serious fault; the stitching was carried through the inner sole and left a ridge which rasped the foot of the wearer. It was limited therefore to cheaper grades of shoes, high grade shoes continuing to be handmade by the welt process.

A welt is a narrow strip of leather to which an inner sole and upper is first sewed and then an outer sole attached. By using a welt a sole can be joined to an upper so that no sewing appears on the inside of the shoe and hence leaves a smooth surface for the foot of the wearer. The origin of the ingenious method by which machinery was applied to welt shoemaking is usually accredited to Auguste Destouy, a New York mechanic. His idea was developed and was finally brought to perfection by Charles Goodyear, son of the inventor of rubber fabrics, who obtained patents for his welt machine in 1871 and 1875. Since Goodyear's machine produced welt shoes that were more comfortable, more exact in workmanship and cheaper than those formerly made by hand, the machine may be credited with founding modern American high grade shoe manufacture. The machines found instantaneous favor and were introduced by the hundred.

672 Courtesy of the United Shoe Machinery Corporation

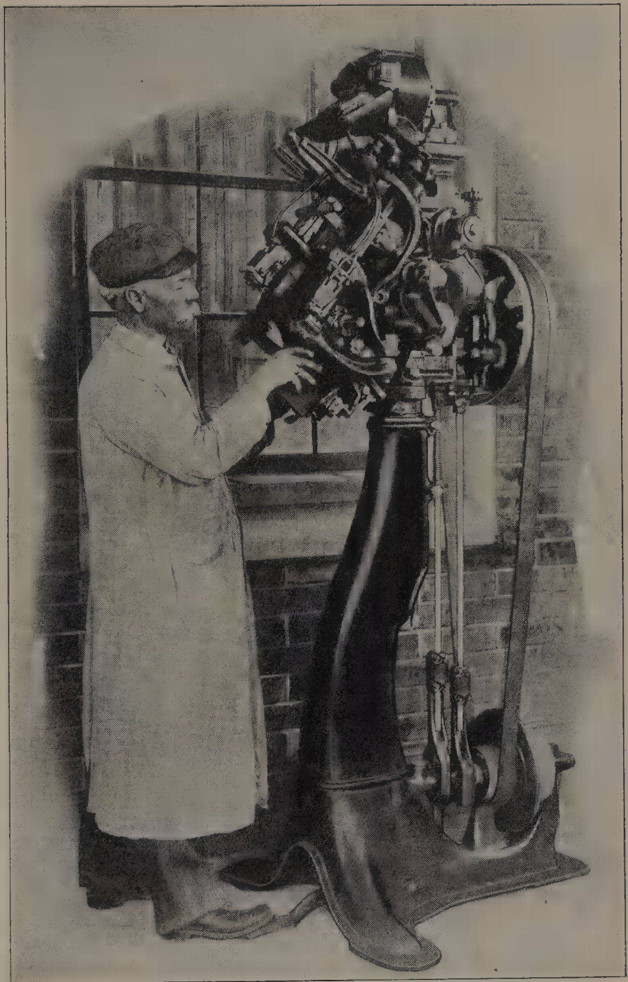
MODERN SHOE MACHINERY

The installation of McKay and Goodyear-welt machines formed the basis for a large number of other associated mechanical devices. Between 1850 and 1900 no less than four thousand patents were issued for the shoe machinery industry. Meanwhile the leading machinery companies combined as the United Shoe Machinery Corporation, which makes nearly every machine used in American shoe factories. The machines are leased rather than sold largely because when the first machines were introduced they were too expensive for shoemakers to acquire on any other basis.

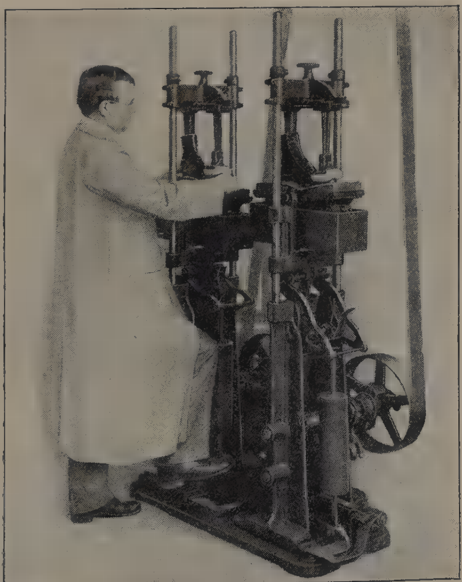
One of the most amazing and relatively recent shoe machines is the "pulling-over machine," which pulls the upper over the sole and holds the upper in place so that the two may be sewed together. It is said that a million dollars was spent in bringing this machine to perfection.

Although few shoe factories use machines for every process, there is a machine available for each one. This is an outstanding achievement for an industry which at the time of the Civil War had almost no machinery at all.

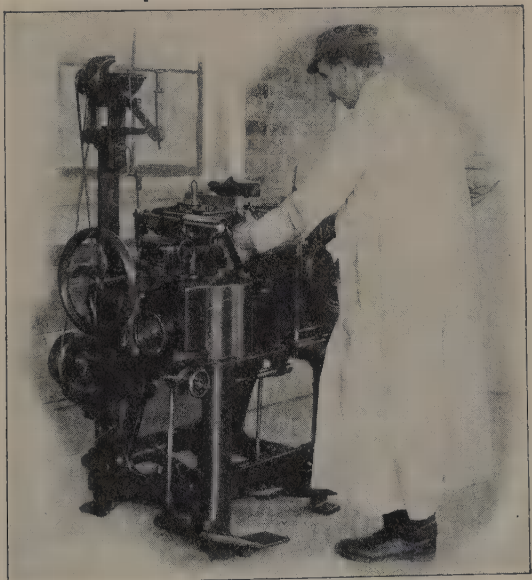
Because the machinery is leased rather than sold there are few very large shoe factories. Most factories are not only small but highly specialized, some of them making only one small part of a shoe.



673 The Pulling-Over Machine, this and the two photographs below, courtesy of the United Shoe Machinery Corporation



674 An Improved Sole-Laying Machine



675 A Lasting Machine

CHAPTER XIV

ORGANIZED LABOR IN INDUSTRY

IN 1920, out of our population of one hundred and five millions, there were forty-one million wage earners. Whatever concerns labor is vital to the well-being of the nation. Industry has advanced from the small-scale local individual enterprise to the gigantic corporation whose business and plants are spread over the nation and even the globe, and various corporations have united in one way or another for economic or political purposes. In like manner labor has forsaken individual bargaining with an employer and has united into great organizations for group negotiations concerning wages, hours, or working conditions with aggregations of employers. The hostler once might haggle with the village liveryman, but the locomotive engineers have been forced to organize a brotherhood to deal with the railroad executives of the country. Labor organization has paced evenly with industrial organization.

The history of labor shows that organization develops under four conditions. (1) The worker must be separated from the ownership of the tools or the means of production. (2) Laborers in the same trade must be able to come into close contact with one another. (3) Opportunities for especially gifted workmen to rise above their class must be shut off, with the result that these men, denied individual advancement, become leaders in the efforts for the improvement of their class. (4) The condition under which work is done must be burdensome, so that the men engaged in the work feel that they have a common grievance. These conditions were not satisfied in America until after 1830, and then only partially until after the Civil War.

There could be no effective labor organizations in the United States in the earlier years of its industrial development. The early artisans in general each carried on his own business. The shoemaker owned his tools and his shop, bought his leather and sold his finished product. With the coming of the first factories employees were gathered together under the same roof and worked for wages with the tools and materials of other men. Under the industrial conditions that prevailed before the Civil War labor unions sprang up from time to time but none were able to maintain an existence over a long period of years. The rapid growth of a nation that was still undeveloped gave opportunities of many kinds. Industry itself was growing and disgruntled employees might get better jobs in new enterprises. Cities were expanding and the laborer might set up for himself in a small commercial enterprise. The frontier always beckoned those who preferred being their own masters to working for hire. The abler members of the labor group were always finding opportunities to improve their condition.

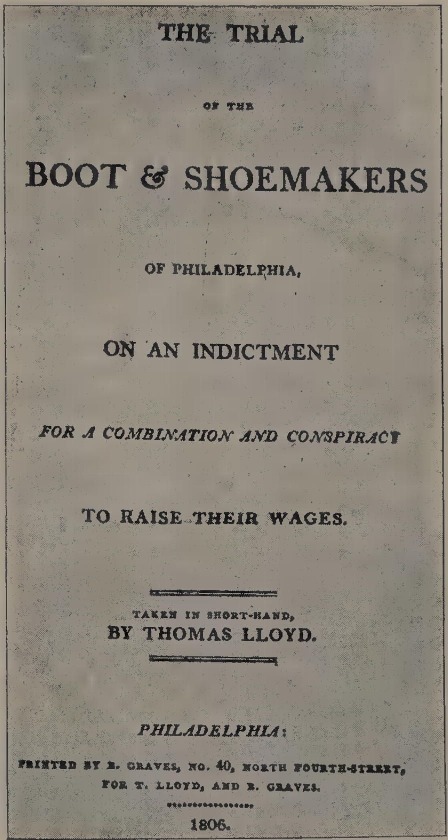
Following the Civil War the great labor organizations of the United States have developed. Many forces have operated to bring them about. Their influence has increased in the development of industry. They are an inevitable and an important part of the new industrial order. At first these unions directed their attention to the betterment of the economic condition of the workers and this aim still remains foremost. But of late years some unions have been paying particular attention to gaining some kind of partnership in industry and may next reach out for a measure of political control.

A TRIAL OF WAGE EARNERS FOR CONSPIRACY

There was no definite attempt to organize labor through the colonial period of America. Following the Revolutionary War there were a few city trades that organized from time to time to gain some desired end. The trades generally affected were the shoemakers and the printers, whose grievances were the abandonment of the apprentice system with consequent incursion of "green hands," and the depression of wages due to the rise of the merchant capitalist. The latter bought under contract from various master workmen in different localities, played one against another, and so forced prices downward.

The shoemakers and printers each on several occasions organized themselves to protest and strike against these practices. The result was that the masters haled them into court on the charge of conspiracy.

Their cases were important to labor because they involved the strike as a labor weapon, but they received much attention because they also had a political and judicial importance. The question was whether British common law, under which the conspiracy cases were brought, was to be accepted as American common law after the Revolution had severed Anglo-American political ties. The decision was that British common law did apply here as part of our common heritage. Whether or not under the common law a strike was a conspiracy, the judges on the various cases were not unanimous in opinion. But the cases checked the growth of unionism.



THE TRIAL

OF THE

BOOT & SHOEMAKERS

OF PHILADELPHIA,

ON AN INDICTMENT

FOR A COMBINATION AND CONSPIRACY

TO RAISE THEIR WAGES.

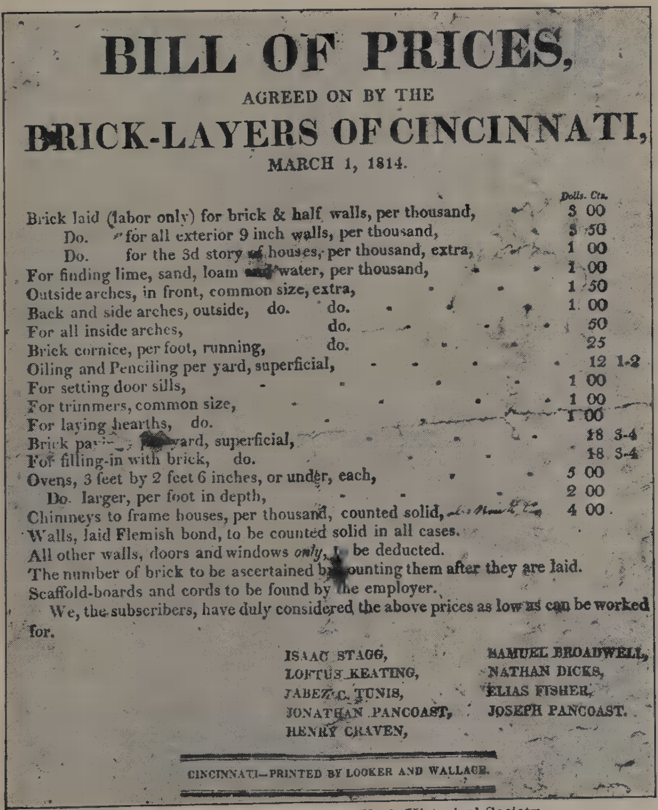
TAKEN IN SHORT-HAND,
BY THOMAS LLOYD.

PHILADELPHIA:

PRINTED BY B. GRAVES, NO. 40, NORTH FOURTH-STREET,
FOR T. LLOYD, AND B. GRAVES.

1806.

676 Title-page of a pamphlet published at Philadelphia, 1806



BILL OF PRICES,

AGREED ON BY THE

BRICK-LAYERS OF CINCINNATI,

MARCH 1, 1814.

	Dolls.	Cts.
Brick laid (labor only) for brick & half walls, per thousand,	3	00
Do. for all exterior 9 inch walls, per thousand,	3	50
Do. for the 3d story of houses, per thousand, extra,	1	00
For finding lime, sand, loam and water, per thousand,	1	00
Outside arches, in front, common size, extra,	1	50
Back and side arches, outside, do. do.	1	00
For all inside arches, do.		50
Brick cornice, per foot, running, do.		25
Oiling and Penciling per yard, superficial,		12 1-2
For setting door sills,	1	00
For trimmers, common size,	1	00
For laying hearths, do.	1	00
Brick pa[illegible]yard, superficial,		18 3-4
For filling-in with brick, do.		18 3-4
Ovens, 3 feet by 2 feet 6 inches, or under, each,	5	00
Do. larger, per foot in depth,	2	00
Chimneys to frame houses, per thousand, counted solid,	4	00

Walls, laid Flemish bond, to be counted solid in all cases.
All other walls, doors and windows *only*, to be deducted.
The number of brick to be ascertained by counting them after they are laid.
Scaffold-boards and cords to be found by the employer.

We, the subscribers, have duly considered the above prices as low as can be worked for.

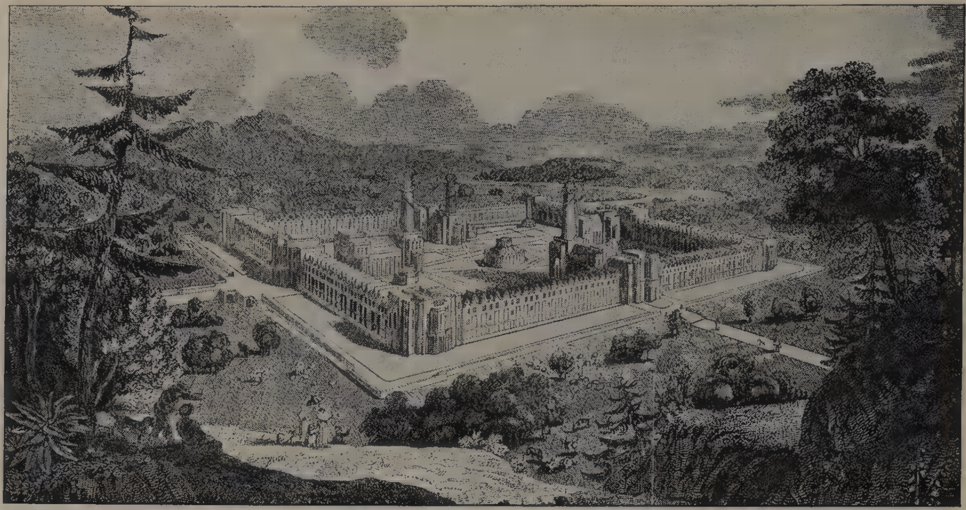
ISAAC STAGG, SAMUEL BROADWELL,
LOFTUS KEATING, NATHAN DICKS,
JABEZ C. TUNIS, ELIAS FISHER,
JONATHAN PANCOAST, JOSEPH PANCOAST.
HENRY CRAVEN,

CINCINNATI—PRINTED BY LOOKER AND WALLACE.

677 From a broadside in the New York Historical Society

A WAGE AGREEMENT, 1814

The slow growth of labor organization in America is partly accounted for by the uniformly high wages as indicated by a bill of prices for 1814. Cincinnati was a frontier town and bricklayers were scarce. For similar work, wages were lower in the East. But even the lower eastern wages were high as compared with the returns for the same kind of work at the time in Europe; and the purchasing power of American wages, at prevailing prices, placed the worker in a position superior to his European brothers. Hence there was small incentive to develop labor organization. Wages were bound to be high in early nineteenth-century America. Every year hundreds of canvas-topped Conestoga wagons were crossing the Appalachian mountains taking emigrants from the East to the fertile agricultural lands of the Mississippi valley. Wages must be attractive to compete with the lure of the West.



678 From *The Co-operative Magazine*, London, 1826

NEW HARMONY, A UTOPIAN EXPERIMENT

Social reform was the first weapon seized by American labor, and this program has been favored over and over again in our labor history. Especially in periods of business depression when other labor weapons are weakened, Utopian communities have appealed to American workers.

Among the earliest reformers to advocate the community idea in America as a means of improving the worker was Robert Owen. Owen, a successful manufacturer of cotton at the New Lanark Mills of Scotland, became persuaded that environment is the most vital element in shaping character. Although at first his ideas were accepted among many in England, he made the mistake of flouting religion, and turned to America to found a colony where environment should be conducive to the development of high character.

His plan was to build a structure in the form of a hollow square in which all the people of a community were to live together by families. Children after the age of three, however, were to be brought up by the entire community. There was to be a common kitchen and dining room. Attached to the project were to be from one thousand to one thousand five hundred acres of land upon which everything was to be raised that would make the community self-sustaining. All the people (five hundred to three thousand) were to work equally and share in common the products of their joint effort.

NEW HARMONY, THE REALITY

Arriving in America, Owen bought from a group of religious enthusiasts a settlement in Indiana called New Harmony and in 1826 began to put his ideas into practice. He attracted to the place a number of reformers of different types, several notable scientists, a sizable group of interested people of no distinction, and a number of casual floaters looking for an easy living.

Almost from the start trouble arose in New Harmony. Slothfulness, jealousy, and the desire of each reformer to push his own favorite program created dissension. Group after group split away from the main body and set up establishments for themselves, but all on Owen's land. Within two years there were ten such secession camps. Discouraged, impoverished, defeated, Owen abandoned New Harmony and returned to Great Britain to engage in other reform movements. New Harmony to-day, long since deprived of its communistic character, has a population of about two thousand.

679 From Maximilian's *Reise in das Innere Nord-Amerika in den Jahren 1832–4*, Coblenz, 1839–41, after the drawing by Carl Bodmer

680 From a photograph taken about 1870, in possession of the Owen family

ROBERT DALE OWEN, 1801–77

ROBERT OWEN'S four sons came with him to the United States and all four eventually became citizens. One was a prominent geologist and another a professor of natural science at Nashville University.

The most famous son was the eldest, Robert Dale Owen, who served two terms in the Indiana legislature and one term as a representative in Congress. It is said that Owen was responsible for the insertion in the Indiana Constitution of 1850 of the provisions giving control of property to married women and widows. He also fought for and secured liberal divorce laws in Indiana. He was closely associated with Frances Wright, one of the first suffragists.

Robert Dale Owen was at the forefront of the labor movement for free schools and took part in the political activities of labor in New York City. Before he died, he became, like his father, an ardent advocate of spiritualism.

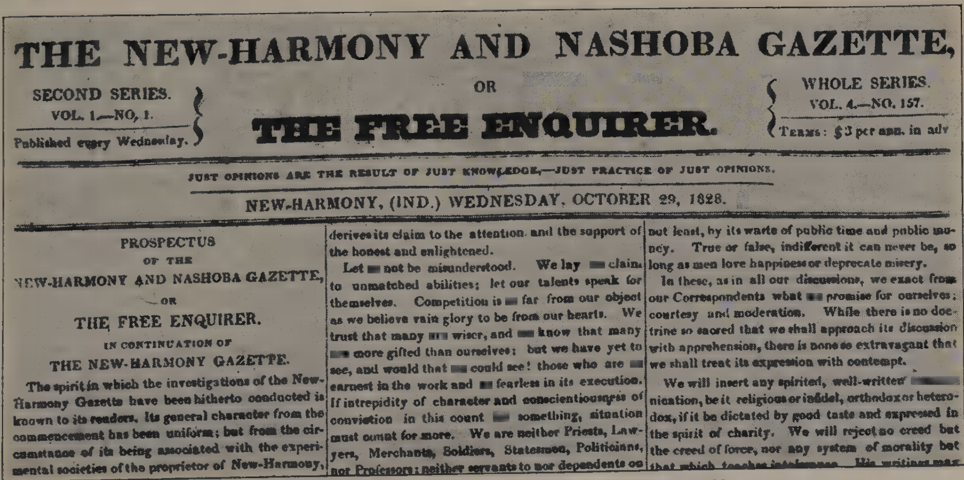
FRANCES WRIGHT, 1795–1852, A SOCIAL REFORMER OF THE 'THIRTIES

AN intimate friend of the Owens in America was Frances Wright. "Fanny" Wright, as she was known in America, was born in Dundee, Scotland, in 1795, where she was left an orphan at an early age. In 1818 she visited America and wrote a description of contemporary American life, now an important source for students of that period.

681 From a lithograph by Lemercier, about 1840, courtesy of the Workingmen's Institute, New Harmony, Indiana

Miss Wright was one of the guiding spirits at New Harmony and was closely attached to the Owens in many enterprises. She advocated many forms of freedom — of speech, of labor, of slaves, and of women from the bonds that tied them, economic, marital and political. She was so much at variance with her times that she met with almost universal condemnation from the press and the pulpit, but a number of "Fanny Wright Societies" were formed to teach her ideas.

The Free Enquirer was the organ of "Fanny" Wright's attacks on the social abuses of her day, the chief of which was the inequality between the rights of property and the rights of men. Begun at New Harmony, this paper was for a time edited by Robert Dale Owen. When Miss Wright came to New Harmony she joined Owen as editor. Later the two moved their paper to New York, where they took a prominent part in the political labor movement of the 'thirties.



THE NEW-HARMONY AND NASHOBA GAZETTE,

OR

THE FREE ENQUIRER.

SECOND SERIES. VOL. 1.—NO. 1. Published every Wednesday.

WHOLE SERIES. VOL. 4.—NO. 157. TERMS: $3 per ann. in adv

JUST OPINIONS ARE THE RESULT OF JUST KNOWLEDGE,—JUST PRACTICE OF JUST OPINIONS.

NEW-HARMONY, (IND.) WEDNESDAY, OCTOBER 29, 1828.

PROSPECTUS OF THE NEW-HARMONY AND NASHOBA GAZETTE, OR THE FREE ENQUIRER. IN CONTINUATION OF THE NEW-HARMONY GAZETTE.

The spirit in which the investigations of the New-Harmony Gazette have been hitherto conducted is known to its readers. Its general character from the commencement has been uniform; but from the circumstance of its being associated with the experimental societies of the proprietor of New-Harmony, derives its claim to the attention and the support of the honest and enlightened.

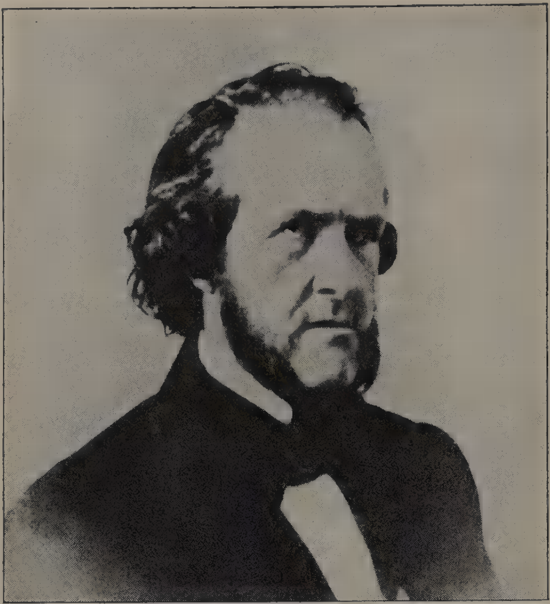
Let [redacted] not be misunderstood. We lay [redacted] claim to unmatched abilities; let our talents speak for themselves. Competition is [redacted] far from our object as we believe vain glory to be from our hearts. We trust that many [redacted] wiser, and [redacted] know that many [redacted] more gifted than ourselves; but we have yet to see, and would that [redacted] could see! those who are [redacted] earnest in the work and [redacted] fearless in its execution. If intrepidity of character and conscientiousness of conviction in this count [redacted] something, situation must count for more. We are neither Priests, Lawyers, Merchants, Soldiers, Statesmen, Politicians, not Professors; neither servants to nor dependents on

not least, by its waste of public time and public money. True or false, indifferent it can never be, so long as men love happiness or deprecate misery.

In these, as in all our discussions, we exact from our Correspondents what [redacted] promise for ourselves; courtesy and moderation. While there is no doctrine so sacred that we shall approach its discussion with apprehension, there is none so extravagant that we shall treat its expression with contempt.

We will insert any spirited, well-written [redacted]nication, be it religious or infidel, orthodox or heterodox, if it be dictated by good taste and expressed in the spirit of charity. We will reject no creed but the creed of force, nor any system of morality but that which teaches intolerance. His writings may

682 Facsimile of part of the front page of the issue of Oct. 29, 1828



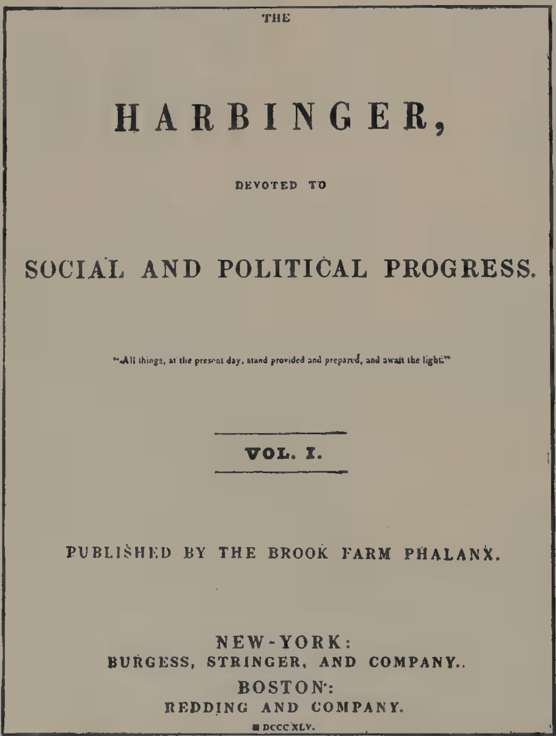
683 Courtesy of Arthur Brisbane, New York

ALBERT BRISBANE, 1809–90

ANOTHER who, like Owen, advocated the solution of labor problems by means of self-supporting communities was Albert Brisbane. The chief influence on Brisbane's life was exerted by François Fourier, the French sociologist, who preached that society progressed upward from plane to plane of happiness and who declared that the way to hasten the process was to gather all those on the same plane into communities, which he called phalanxes. Although the doctrine had run its course in France and several phalanxes had already collapsed, Brisbane attempted to set up similar phalanxes in America.

FOURIERISM IN AMERICA

BROOK FARM, a communistic experiment of certain New England intellectuals, was converted by Brisbane into a phalanx, and another community, now Red Bank, New Jersey, sprang into fame. These and several similar enterprises repeated the old story of dissension, misfortune, and eventual failure.



THE

HARBINGER,

DEVOTED TO

SOCIAL AND POLITICAL PROGRESS.

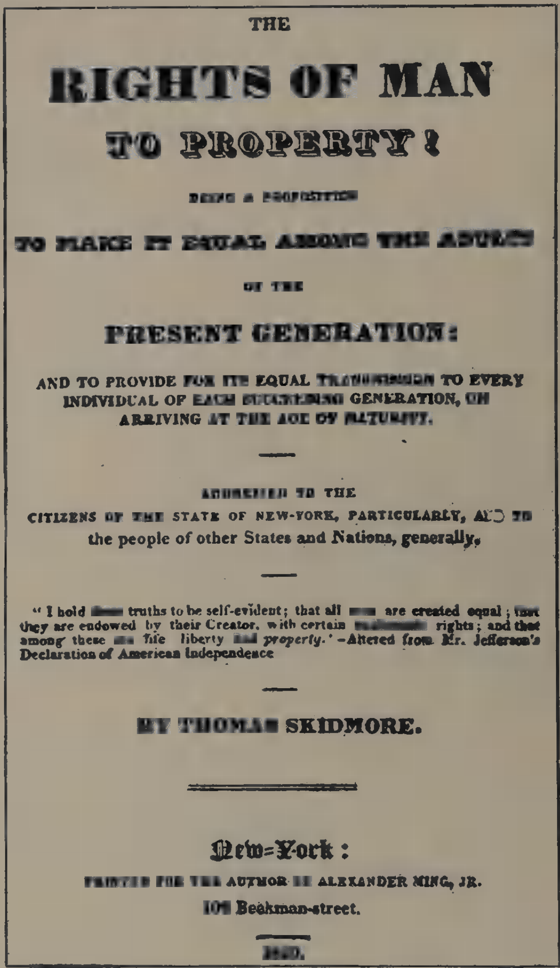
"All things, at the present day, stand provided and prepared, and await the light."

VOL. I.

PUBLISHED BY THE BROOK FARM PHALANX.

NEW-YORK:
BURGESS, STRINGER, AND COMPANY.
BOSTON:
REDDING AND COMPANY.
MDCCCXLV.

684 Title-page of Vol. I of *The Harbinger*, published in 1845 by the Brook Farm phalanx



THE

RIGHTS OF MAN

TO PROPERTY!

[illegible]

TO MAKE IT EQUAL AMONG THE ADULTS

OF THE

PRESENT GENERATION:

AND TO PROVIDE FOR ITS EQUAL TRANSMISSION TO EVERY INDIVIDUAL OF EACH [illegible] GENERATION, ON ARRIVING AT THE AGE OF MATURITY.

ADDRESSED TO THE
CITIZENS OF THE STATE OF NEW-YORK, PARTICULARLY, AND TO
the people of other States and Nations, generally.

"I hold [illegible] truths to be self-evident; that all [illegible] are created equal; [illegible] they are endowed by their Creator, with certain [illegible] rights; and that among these [illegible] life liberty [illegible] *property*.' —Altered from Mr. Jefferson's Declaration of American Independence

BY THOMAS SKIDMORE.

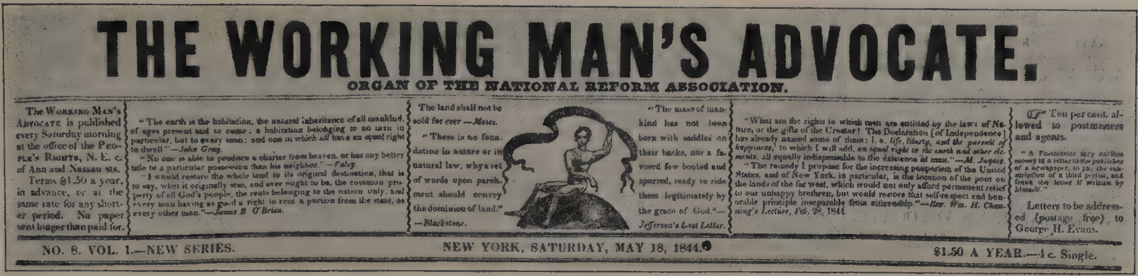
New-York:
PRINTED FOR THE AUTHOR BY ALEXANDER MING, JR.
[illegible] Beekman-street.

[illegible]

685 Title-page of a pamphlet published in 1829

AGRARIAN REFORMERS

LABOR reformers also sought to abolish inequality of property ownership. This idea first became prominent in the 'twenties. Its principal advocate, Thomas Skidmore, prominent in the political labor movement of his day, proposed that the state take over all existing property and divide it equally among all the citizens.



THE WORKING MAN'S ADVOCATE.

ORGAN OF THE NATIONAL REFORM ASSOCIATION.

The Working Man's Advocate is published every Saturday morning at the office of the People's Rights, N. E. c. of Ann and Nassau sts.

Terms $1.50 a year, in advance, or at the same rate for any shorter period. No paper sent longer than paid for.

"The earth is the habitation, the natural inheritance of all mankind, of ages present and to come; a habitation belonging to no man in particular, but to every man; and one in which *all* have an *equal* right to dwell."—*John Gray.*

"No one is able to produce a charter from heaven, or has any better title to a particular possession than his neighbor."—*Paley.*

"I would restore the whole land to its original destination, that is to say, what it originally was, and ever ought to be, the common property of all God's people, the rents belonging to the nation only, and every man having as good a right to rent a portion from the state, as every other man."—*James B. O'Brien.*

The land shall not be sold for ever.—*Moses.*

"There is no foundation in nature or in natural law, why a set of words upon parchment should convey the dominion of land."—*Blackstone.*

"The mass of mankind has not been born with saddles on their backs, nor a favored few booted and spurred, ready to ride them legitimately by the grace of God."—*Jefferson's Last Letter.*

"What are the rights to which men are entitled by the laws of Nature, or the gifts of the Creator? The Declaration [of Independence] has already named some of them: i. e. *life, liberty, and the pursuit of happiness,* to which I will add, *an equal right to the earth and other elements,* all equally indispensable to the existence of man."—*M. Jaquey.*

"The remedy I propose for the increasing pauperism of the United States, and of New York, in particular, is the location of the poor on the lands of the far west, which would not only afford permanent relief to our unhappy brethren, but would restore that self-respect and honorable principle inseparable from citizenship."—*Rev. Wm. H. Channing's Lecture, Feb. 2?, 1844.*

☞ Ten per cent. allowed to postmasters and agents.

"A Postmaster may enclose money in a letter to the publisher of a newspaper, to pay the subscription of a third person, and frank the letter if written by himself."

Letters to be addressed (postage free) to George H. Evans.

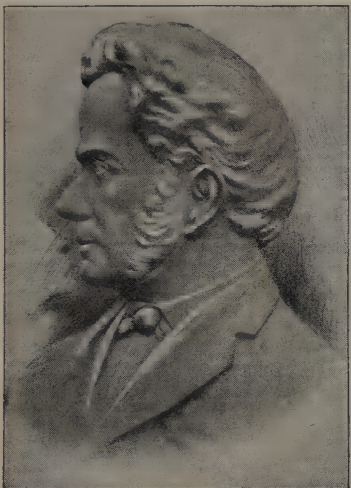
NO. 8. VOL. 1.—NEW SERIES. NEW YORK, SATURDAY, MAY 18, 1844. $1.50 A YEAR.—4 c. Single.

686 Facsimile of the title of the issue of May 18, 1844

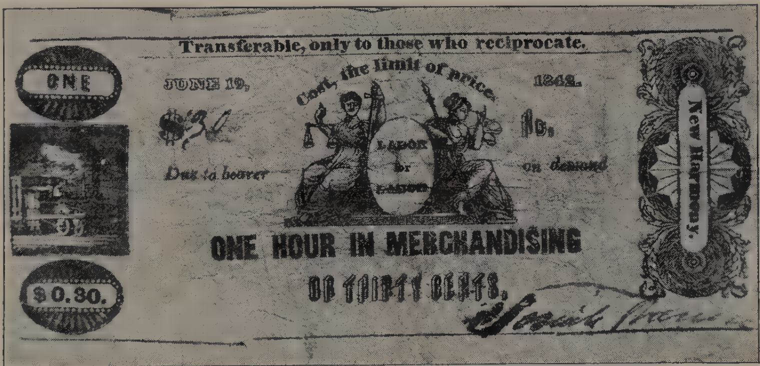
GEORGE HENRY EVANS AND LAND REFORM

The Skidmore program came to nothing, but in the early 'forties George Henry Evans, a Welshman, proposed an adaptation of the idea that was more workable. He called attention in his newspaper *The Working Man's Advocate* to the vast amount of idle unoccupied land. He said, "Give this land to all who will take it and make good use of it." At the time it was predicted that it would take from four hundred to nine hundred years to settle the public domain, judging by the number of sales then taking place, and the extent of the land available.

Evans' theory, also advocated by many others, particularly those with some special interest in the West, either economic or political, developed into the agrarian movement. Of course it met with opposition. Southern slaveholders feared it would restrict the expansion of slavery, eastern landlords execrated it because it meant the fall of rents, employers decried it for the double reason that it would remove labor and raise wages; capitalists frowned upon it because it would lower the value of their eastern investments, and dump upon the market a new class of risky investments in pioneer western communities. The power of the South in Congress prevented any action until the Civil War. Then the Homestead Act went through and thirty years of agrarianism came to a successful conclusion.



687 Josiah Warren, 1799–1874, from a bust by Sydney H. Morse in the Workingmen's Institute, New Harmony



688 Labor Note issued by Warren at New Harmony, from the original in the Workingmen's Institute, New Harmony

THE "TIME STORE" AND THE LABOR NOTE

Josiah Warren, also a communist, proposed to substitute for a currency based on metals a currency based on a unit hour. He made no discrimination as to the kind of labor but merged skilled and unskilled in his calculations. An hour's time of a bricklayer, doctor or ditch digger was evaluated alike. Warren issued notes in denominations representing labor time and used these notes in place of money. For two years (1826–28), in his retail "time store" in Cincinnati, he accepted his own labor notes as currency. He also ran a similar store at New Harmony. Since he could not get his own creditors to accept the same currency, the store was finally closed. Warren eventually became an anarchist, and is credited with being the first American to espouse this philosophy.

The projects of Warren, Owen and Frances Wright were but a phase of an intellectual ferment working in early nineteenth-century America. It was a day of reform movements. Some organizations were seeking prison reforms, others the building of asylums for the insane. Temperance societies were beginning the long war on alcohol and the saloon. The Sunday school was a new thing. Antislavery societies were initiating that crusade which was to end only with Civil War. With the rest labor was struggling forward.


of whole heart cometh hope.

This is to Certify that ....
is enrolled a Member of the Women's Co-operative Guild: a self-governing organization of .... Women, who work through Co-operation for the welfare of the people, seeking Freedom for their own progress, and the Equal Fellowship of men and women in the Home, the Store, the Workshop and the State.

Date. General Secretary.

689 A Certificate of Membership in a Coöperative Organization, courtesy of the Coöperative League of America, New York

THE COÖPERATIVE MOVEMENT

Coöperation in production, credit and consumption has been another social reform close to the heart of the labor movement. One of the first leaders in this program was Thomas Phillips, a shoemaker who, emigrating to the United States from England in 1852, sought to transplant the Rochdale coöperative movement in America.

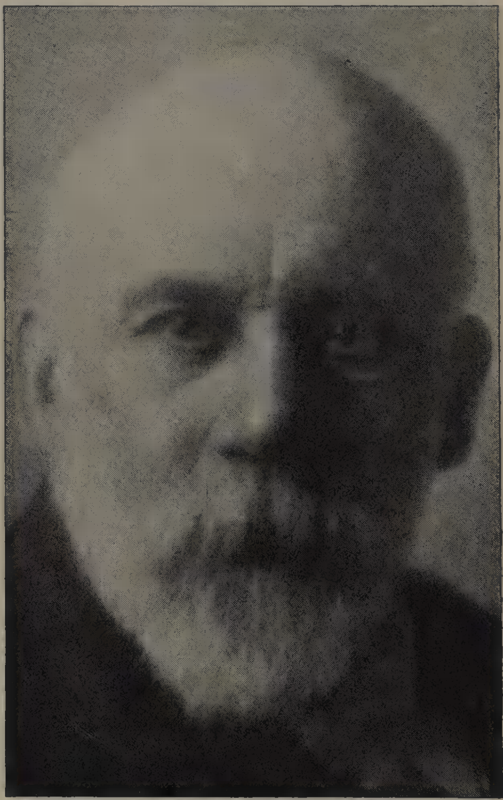
Producers' coöperation, tried over and over again in the United States, has never succeeded. Enterprises that have been started in this way, if continued, did so as regular joint-stock associations with one or more dominant "bosses." Otherwise these experiments have failed. The same is true of consumers' coöperation. The reasons seem to be that Americans are not impressed with the small savings possible in coöperative stores and will not inconvenience themselves to patronize such stores. The American workers, too, lack the homogeneity necessary to coöperative success. What coöperatives we have had have suffered from incompetent or dishonest management. The chain store system, although frankly capitalistic and run for private gain, fills the need in this country that is met elsewhere by the coöperative store.

Coöperative credit in building and loan associations, however, has been successful to a high degree in America. This is because such loans provide the means for workmen and others to obtain money on terms impossible through the regular banks. This is one of the best devices for improving the lot of those who earn wages.

BEGINNINGS OF AMERICAN SOCIALISM

In this country the labor movement has never entered officially into politics under the Socialist banner. Most of the rank and file support of Socialism in America, until recently, has come from German immigrants in their first years in the United States. Leaders, however, have been most frequently Americans of longer standing. The father of American Socialism is said to have been F. A. Sorge, who promoted this program in the 'seventies. In the two following decades Daniel De Leon was a leader of the Socialists. Since 1890 there have been many leaders, but the most prominent figure has been Eugene V. Debs. The Marxian doctrines have not been hailed with the enthusiasm in America that they have met with in parts of Europe.

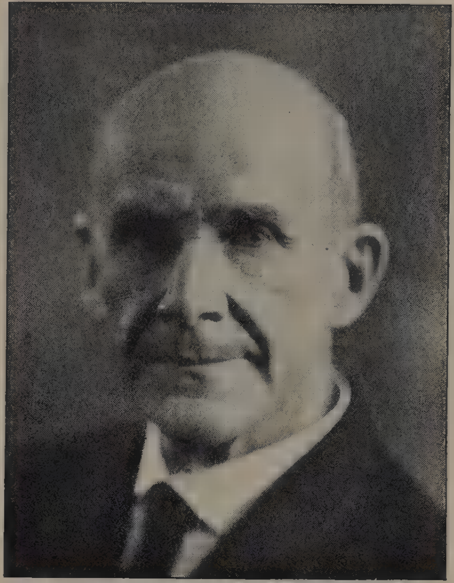
The Socialists within the American labor movement and those outside it have endeavored continuously to swing organized labor into the ranks, but organized labor in this country has always resisted such attempts. Probably Socialism and all other radical programs of social reform have no more bitter and determined enemies than the men who control organized labor in America.



690 Daniel De Leon, 1852–1914, from a photograph, courtesy of the National Executive of the Socialist Labor Party, New York

"GENE" DEBS, 1855–1926

Eugene Victor Debs, the outstanding Socialist of America, was born in Terre Haute, Indiana, in 1855. He began his career as a locomotive fireman, was once an official in the Brotherhood of Locomotive Firemen, and also a representative in the Indiana legislature. His surging spirit, however, would not permit him to sanction the opportunistic conservative policies of the Brotherhood, so he organized and was president of the American Railway Union, the group that led the famous Pullman strike as a result of which Debs went to jail. Since 1900, Debs has been five times the Socialist candidate for President of the United States, the last time in 1920, when he was in the Atlanta penitentiary for his opposition to the World War. Debs is a lecturer, writer, and organizer for the Socialists in the United States, besides being their favorite candidate for high office. Despite differences of opinion concerning the ideas Debs has advocated, few have questioned his integrity, sincerity and high idealism.



691 From a photograph by Humboldt Studios, Chicago

THE INDUSTRIAL WORKERS OF THE WORLD

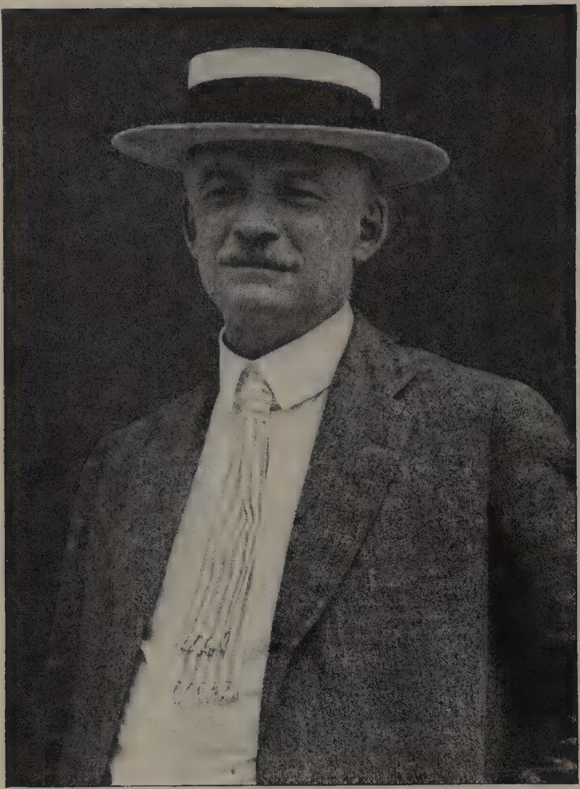
Of quite a different ilk have been the leaders of the Industrial Workers of the World. State Socialism proposes state ownership and operation of all necessary industries. Syndicalism goes a step further, throwing overboard all idea of political government and concentrating upon industrial government. It proposes to give to the workers the ownership and operation of industry.

The nearest approach to syndicalism in the United States is found in the Industrial Workers of the World. This organization was formed in 1905, largely by the efforts of William D. Haywood — "Big Bill" — and comprised the radical Western Federation of Miners, Socialists under the leadership of Debs and Berger and another wing of the Socialists under Daniel De Leon. These various elements differed in their views of politics as the means to their ends, in their allegiance to sabotage — "direct action" — and in their concept of a proper working class economic organization. In 1908 a split came, and the I. W. W. that emerged under Haywood disavowed politics, upheld organization of all workers in an industry regardless of craft, sought to overthrow capitalism and to substitute worker ownership and operation of industry.

This organization attracted to itself the unskilled and casual laborers of the West and finally united with itself the radical minded workers of the eastern textile industries. Its greatest demonstrations were the textile strikes of Lawrence, Massachusetts, and Paterson, New Jersey — led by Joseph Ettor — and the casual labor disturbances in the West during the World War. The I. W. W. has always had to deal with internal dissension, and has never had more than sixty thousand members at one time, an insignificant number for an organization with such vast ambitions.

692 William D. Haywood and Joseph Ettor at Lawrence, 1912. © Brown Brothers

Haywood, long ago discouraged with the I. W. W., withdrew from it and took up Bolshevism. He was brought to trial for his radicalism, but defaulted his bail and went to Russia in 1921. There he was given scant welcome by the Bolshevists. He is a disappointed, hopeless man; he has spent his life in endeavoring to raise the masses, but the masses disown him.



693 Glenn E. Plumb, 1866–1922. © Brown Brothers

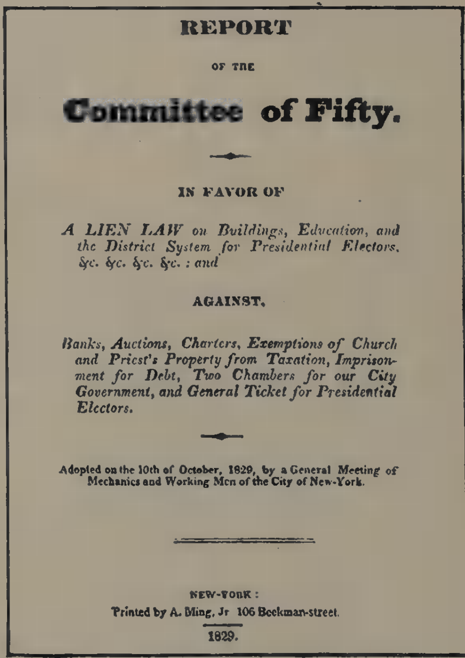
THE "PLUMB PLAN"

Socialism has many phases. One type is called Guild Socialism. This program of social reform proposes that the government own all the industries, but that the workers operate them. We have no active Guild Socialists in the United States, but after the World War a plan approaching the doctrine was put forth by Glenn E. Plumb, then General Counsel for the Railway Brotherhoods. The "Plumb Plan" called for government ownership of the American railroads and was accepted by the four railway brotherhoods and by the railway unions affiliated with the American Federation of Labor. It was urged upon Congress, but was not enacted into law.

It provided that the United States government buy the railroads from their private owners, but at a price that would exclude payment on watered stock. It was then to lease them to a private operating company whose managing board of fifteen should have five representatives of the public, five of the salaried executive officials of the railroad, and five of the wage earners of the road. A fixed return on the capitalization was specified. Larger returns were to accrue in part to the government, in part to the workers in the form of higher wages and in part to the users of the road in lower rates.

THE WORKINGMEN'S PARTIES OF THE 'THIRTIES

The movement for democracy which achieved a national triumph in the elevation of Andrew Jackson to the Presidency in 1829 did much to increase the political significance of the common man. In state after state universal manhood suffrage was adopted. For the first time in the history of labor in America, the great majority of laboring men had the ballot. Their earliest instinct seems to have been the formation of labor parties. In 1828 the first workingmen's party in the United States was organized in Philadelphia by mechanics. At the same time laborers in New York were restless and the Philadelphia experiment attracted attention. New York workingmen came together in a series of meetings at one of which a committee of fifty was appointed to draw up a platform and designate candidates. Internal dissension together with lack of support from the voters resulted in the disintegration of the movement and within a few years it disappeared entirely. The labor vote, however, was from this time on recognized as a factor in politics.



REPORT

OF THE

Committee of Fifty.

IN FAVOR OF

A LIEN LAW on Buildings, Education, and the District System for Presidential Electors, &c. &c. &c. &c. : and

AGAINST,

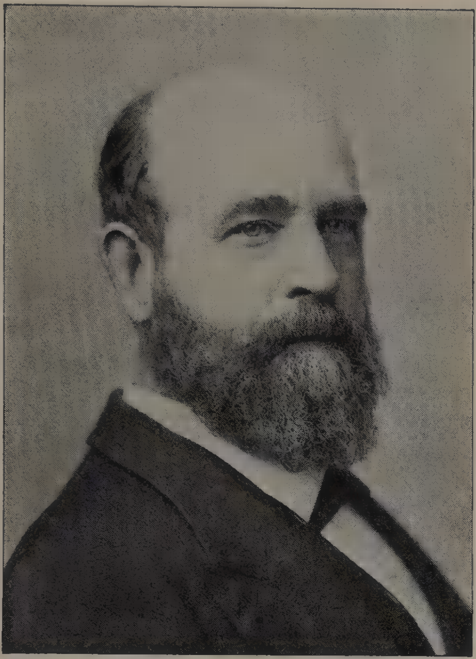
Banks, Auctions, Charters, Exemptions of Church and Priest's Property from Taxation, Imprisonment for Debt, Two Chambers for our City Government, and General Ticket for Presidential Electors.

Adopted on the 10th of October, 1829, by a General Meeting of Mechanics and Working Men of the City of New-York.

NEW-YORK:
Printed by A. Ming, Jr 106 Beekman-street.
1829.

694 From a pamphlet, New York, 1829, in the New York Public Library

The demands of the labor parties of the 'thirties included reform in the banking system, a mechanic's lien, abolition of imprisonment for debt, public education of the children of the poor, abolition of compulsory militia service, and electoral reform. The workingmen themselves were not strong enough to carry out these reforms. Nevertheless the agitation of these reforms by the workingmen was an important factor in creating the public opinion which eventually led to their adoption.



695 Henry George, 1839–97, from a photograph by Sarony

THE HENRY GEORGE CAMPAIGN, 1886

The incitement to form a separate labor political party has generally been the failure of strikes or a prolonged business depression or both. Perhaps the most famous illustration of labor's entrance into politics was the New York City mayorality contest of 1886. It followed a series of strikes and court decisions concerning boycotts that were disastrous to labor. New York City had a strong influential Central Labor Union, organized in 1881 and numbering about fifty thousand members. The Union in 1886 decided that political action was the prime means of promoting the best interests of the laboring class; indeed, it had acted on this principle since 1882 when it entered candidates for Congress, the New York Assembly and the Board of Aldermen. It now approached Henry George to find out if he would be its candidate for Mayor of New York. George was in high favor with the workmen since the publication of his famous book *Progress and Poverty*, 1879.

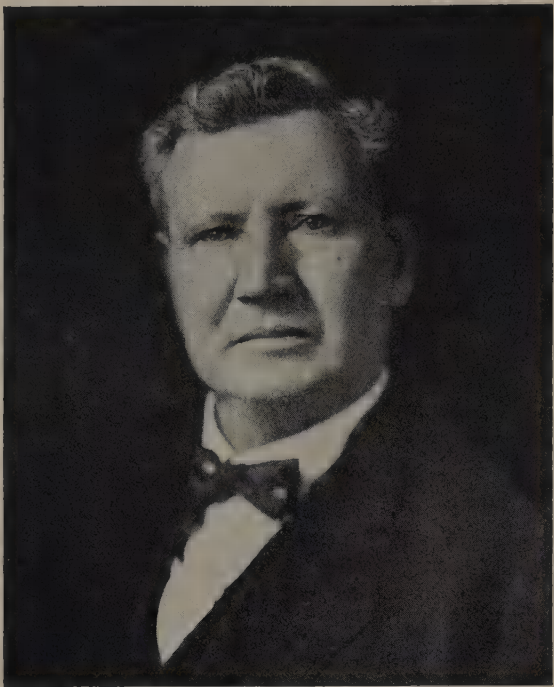
Seldom has New York seen such a campaign. The accredited parties, the press, and all the beneficiaries of special privilege were against George and the Central Labor Union. The Republican candidate was Theodore Roosevelt; Abram S. Hewitt the Democratic. The campaign took on the aspects of religious frenzy and was marked by the bitterest personal abuse. George lost by about twenty-two thousand votes out of a total of about two hundred nineteen thousand. George and his friends, heartened by this result, then proceeded to form a national labor party and to run George for secretary of state of New York. But the polling day was the crest. Internal dissension over Socialism and the single tax rent the party in pieces and within a few short months it was dead. Its national campaign never materialized.

LABOR'S NON-PARTISAN POLITICAL PROGRAM

The George-Hewitt campaign was typical of the history of separate labor parties. Experience, often repeated before the 1890's, taught labor that separate political parties do not work. Internal dissension among the reformers who compose the party, inexperience in the machinery of party politics, unwise selection of candidates or issues, the capture of popular issues by the regular parties, slander, vilification, ridicule — all these things have been factors in the destruction of separate labor political parties.

After the 'nineties organized labor did not officially enter politics as a separate party except for the half-hearted quasi-official endorsement of the La Follette candidacy in 1924. Instead, it has adopted the policy "Vote for friends, defeat our enemies." This means that labor studies candidates and their political records and then, regardless of party, votes for the individuals who seem to lean most favorably toward labor's desires. This policy has brought organized labor rich reward in the form of desired legislation.

696 From the *American Federationist*, August, 1924, cartoon by John Baer



697 William B. Wilson, 1862–, the first Secretary of Labor. © Harris and Ewing

LABOR WINS A CABINET SEAT

In carrying out its political policy of voting for friends and against enemies, organized labor at each national presidential election draws up its own platform and then submits it to each regular party's national convention. The party which includes the greater portion of the labor plank in its own platform then receives the official support of organized labor.

It happened for many elections prior to 1912 that it was the Democratic party that most often and fully espoused the labor demands in their platform, and in turn obtained the support of the officials of organized labor. Since the Democrats lost consistently, this mutual aid did neither group much good. But when the Democrats won the election of 1912, organized labor reaped the harvest of its years of support.

Among the first things accomplished (March 4, 1913), was the creation of a separate Department of Labor, whose head was a member of the cabinet. William B. Wilson, an ex-officer of the United Mine Workers Union, was appointed Secretary of Labor, and thus organized labor had a member in the cabinet without having a separate labor political party. Likewise organized labor was allowed to dominate nearly every portion of the Department of Labor. Organized labor thus became part of the government. William B. Wilson was born in Scotland in 1862 and came to the United States in 1870. Until 1898 he worked as a miner, then became an officer of the Miners' Union. From 1907 he was a congressman, representing a mining district of Pennsylvania.

THE CLAYTON ACT, 1914

Organized labor gained another advantage after 1912 as a result of Democratic party favor. One of the longstanding grievances of labor was the fact that the courts had construed the Sherman Anti-Trust Act as applicable to labor organizations. To remove themselves from this category, organized labor secured, in 1914, the passage of the Clayton Act, sponsored by Henry De Lamar Clayton, representative from Alabama. This act declares that the labor of a human being is not a commodity or article of commerce and that therefore labor organizations shall not be construed as illegal combinations or conspiracies in restraint of trade under the antitrust laws. The act also limited somewhat the use of injunctions as weapons against labor.

The Clayton Act was hailed by labor as its great liberator. But judicial decisions have so construed the act that the labor unions have not received from it the full measure of immunity supposed to have been accorded at the time that the law was passed.

Henry De Lamar Clayton, born in Alabama in 1857, the son of a Confederate officer, studied law and became a United States District Attorney for the Middle District of Alabama. He was a member of Congress from 1897 to 1915.

698 Henry De Lamar Clayton, 1857–. © Harris and Ewing

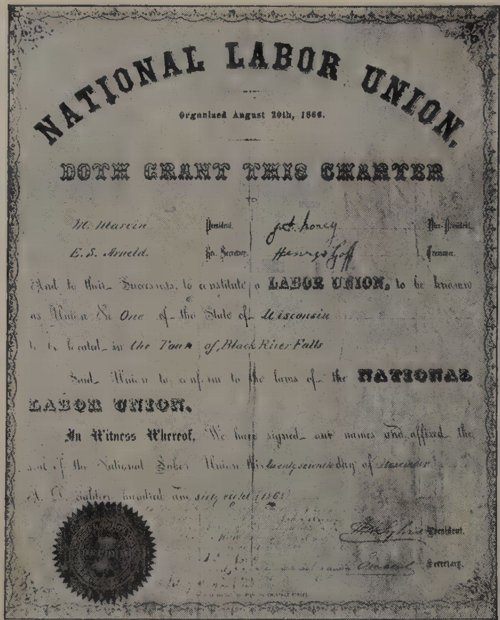
THE ADAMSON ACT, 1916

THE Adamson Act was a piece of legislation somewhat akin to the Clayton Act in that it granted special favor to labor. Ostensibly the act legalized the eight-hour day for railroad workers; in fact, it made eight hours a basis for estimating wages but permitted overtime work at overtime rates. It was thus in effect a wage-raising law. The manner of its passage, under duress through the threat of a strike at the opening of the World War, tended to alienate public opinion from labor measures and it has ever since been used as a bogey by the enemies of organized labor.

699 From the *New York Tribune*, Sept. 4, 1916, cartoon by Starrett

The origin of the trouble that led to the Adamson Act was a demand in December, 1915, of the Brotherhood of Locomotive Engineers for an eight-hour day and a statement that they would not arbitrate this issue. They refused arbitration as provided by law (Newlands Act) on the grounds that the railroad officials had unfairly aroused an unfavorable public opinion and would overwhelm any arbitrators with a mass of cleverly disguised false statistics, that the Newlands Act had failed in previous cases, that the railroads refused to include all railroads in any arbitration proceedings and that the railroads interpreted arbitration decrees to suit themselves. All efforts to bring the railroad officials and Brotherhood officers to an understanding and settlement failed. President Wilson therefore called both sides to Washington and then, after hearing them, went in person before Congress on August 29, 1916, and on his urgent recommendation, Congress immediately passed the Adamson Act as a war measure. Few events of the war years caused such a storm of controversy as the Adamson Act, and the storm has not abated. Whenever the act is mentioned it fans the fury of proponents and opponents.

700 From *The Masses*, Nov., 1916, cartoon by Maurice Becker (1889–)


NATIONAL LABOR UNION,
Organized August 20th, 1866.
DOTH GRANT THIS CHARTER
to
W. Marvin President, J. A. Honey Vice-President,
E. S. Arnold Rec. Secretary, Henry Goff Treasurer.
And to their Successors, to constitute a LABOR UNION, to be known as Union No. One of the State of Wisconsin to be located in the Town of Black River Falls
Said Union to conform to the laws of the NATIONAL LABOR UNION.
In Witness Whereof, We have signed our names and affixed the seal of the National Labor Union this twenty seventh day of December A. D. eighteen hundred and sixty eight (1868)
President.
Secretary.

701 Charter of a Local of the National Labor Union, from original in the office of the American Federation of Labor

THE NATIONAL LABOR UNION, 1866

LABOR nowadays seeks its end by economic pressure, that is, by strikes and boycotts. Its principal weapon is the craft union. An important phase of labor history has been the attempt to unite the unions on a national scale and give the labor movement a head.

The National Labor Union, formed immediately after the Civil War, was one of the first attempts to federate. The first convention, held in 1866, endorsed enthusiastically the Shorter Work Day program, and took active steps to secure the eight-hour day. But instead of relying upon economic pressure the Union launched out into politics.

The second convention, in 1867, intensified the National Labor Union's departure from economic pressure into the vague realm of social and political reform. In the six years of the National Labor Union's life it embraced nearly all the doctrines and committed almost all the errors of its predecessors. Consequently the trade-union membership deserted it and the federation sank out of sight.

WILLIAM H. SYLVIS, 1828–69

THE leader in the organization of the National Labor Union was William H. Sylvis, head of the Iron Molder's Union. Born in Armagh, Pennsylvania in 1828, Sylvis was forced by his father's failure as a wagon builder in 1837 to become an apprentice in a foundry. After serving as a journeyman he became part owner of a Philadelphia foundry, an enterprise which failed and left him again as a journeyman. The iron molders of Philadelphia organized their first union in 1855, but Sylvis did not join until two years later when there was a strike in the foundry in which he worked. After joining he was elected secretary, and from that time his career was identified with the union movement. Due to his skill, energy, and talent, he became the foremost labor leader of his day. Sylvis' last work was the foundation of the National Labor Union, but he died suddenly in 1869 before his plans for this organization had borne fruit.


702 From *The Life, Speeches . . . of William Sylvis*, Philadelphia, 1872


703 Ira Steward, 1831–83, from the portrait in the office of the American Federation of Labor

IRA STEWARD AND THE EIGHT-HOUR DAY

IRA STEWARD, a Boston machinist, born in 1831, who educated himself by reading and study, put a stamp upon the labor movement that has lasted until the present time, although Steward was a free lance working outside the movement of organized labor. He was the first advocate of the eight-hour day, from the time he was nineteen until his death in 1883. The man and the movement were inseparable. Steward's individual reform program was merged in the regular organized labor platform in the 'sixties.

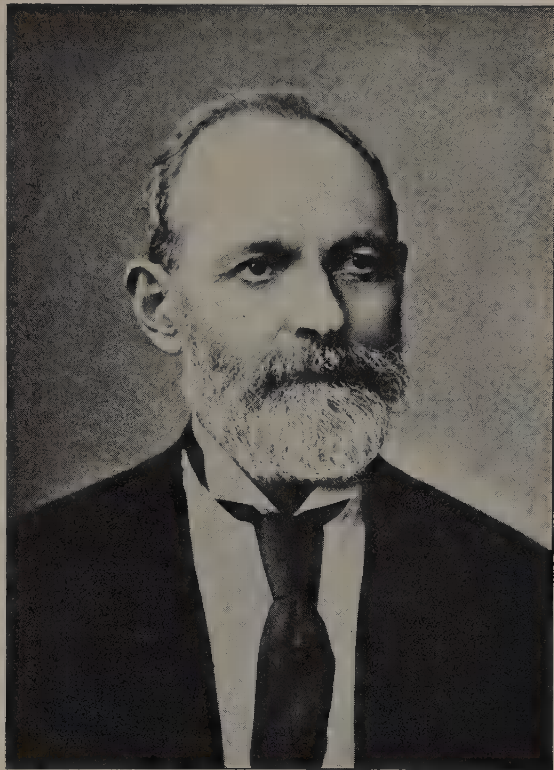
Steward's theory was that an increase in a worker's leisure increases his wants. These can be satisfied only by an advance in wages. This argument gave rise to the slogan, "Whether you work by the piece or work by the day, decreasing the hours increases the pay."

Steward himself favored legislation rather than trade unionism as the means of shortening the workday, but the labor movement seized Steward's idea without adopting his method. The Shorter Work Day became a cardinal principle of craft unionism.

FORMATION OF THE KNIGHTS OF LABOR, 1869

The first really great labor organization in the United States was called the Noble Order of the Knights of Labor. This order was born in Philadelphia in 1869; its father was a Philadelphia tailor named Uriah Smith Stephens, a man who had been educated for the Baptist ministry and had been a school-teacher.

At first Stephens intended to limit his membership to the needle trades, but soon after the first local lodge was formed, the order broadened beyond the clothing industry. Eventually there was no bar to membership; race, creed, color, sex and occupation made no difference. The only persons denied admittance were liquor dealers, lawyers, bankers, professional gamblers, stock brokers and — prior to 1881 — physicians. The Knights of Labor was welcomed both by the workers and by the reform element among the middle class and it grew rapidly.



704 Uriah S. Stephens, 1821–82, from a photograph, courtesy of Terence V. Powderly

SECRET RITUAL OF THE KNIGHTS OF LABOR

In organizing the Knights of Labor Stephens intended it to be a secret society, a policy which was defended on the ground that it was a security against prosecution by employers. Even the name was kept secret and announcement of meetings was made in mysterious symbols. From these facts and from a reading of the ritual (seen in part in No. 705), it is easy to see that the Knights at first resembled a fraternal society rather than a union.

This secrecy, however, was the cause of public indignation. The first Ku Klux Klan was well known; the Commune of Paris, the ravages of the Molly Maguires in the coal regions of Pennsylvania, were contemporary events. A secret labor society called together by cabalistic signs was a source of terror. Public opinion forced the Knights in 1878 to abandon secrecy.

OPENING SERVICE.

A Globe being placed on the outside of the Outer Veil; a copy of the Sacred Scriptures closed, and a box or basket, containing blank cards on a triangular Altar, red in color, in the centre of the vestibule: a Lance on the outside of the Inner Veil, or entrance to the Sanctuary, over the wicket; that the initiated may know that an Assembly of the * * * * * * * * are in session.

The M. W. will proceed to open an Assembly in due form as follows:

Precisely at the hour for opening, the M. W. standing at the Capital, shall give one rap and say, "All persons not entitled to sit with us will please retire." After a short pause, he will say:

M. W. The proper Officer will satisfy himself that all present are entitled to sit with us, and make the proper record.

The W. Ins. examines all present, and makes the proper record in the M. W. roll book. Members at a distance of three miles, or out of the State; any one reported sick, or Brothers absent from the city reporting by letter, receive a present mark. When done, reports as follows:

W. I. M. W., I have examined all, and will make the proper record.

M. W. W. F. see that the Veils are properly marked and securely closed. Allow none to enter or retire during the Opening Service, and that the O. Esq. and all Brothers are in the Sanctuary.

The W. F, after attending carefully to the duties reports thus:

W. F. M. W. the Veils are properly marked and securely closed, the O. Esq and all Brothers are in the Sanctuary.

Give three raps. The Organist may perform a symphony, and appropriate Odes may be sung, if there be such arrangements for music. The officers each bearing his standard and insignia of office, form a circle around the centre, at which is a square Altar, on which is spread open a copy of the Sacred Scriptures; the officers in position as near on a line from the centre to their stations in the Sanctuary as may be; the members, as many as can, standing by the side of the officers to form a complete circle or circles on the outside. Perfect quiet being had, the M. W. shall say an extract from the Sacred Scriptures appropriate to the occasion, such as this, for example:

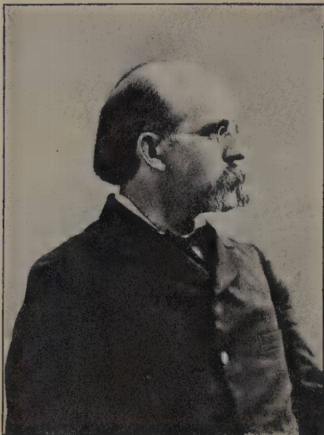
M. W. Behold how good and how pleasant it is for brethren to dwell together in unity. It is like precious ointment upon the head, as the dew of Hermon, and as the dew that descended upon the mountains of Zion, for there the Lord commanded the blessing, even life forevermore.

Turning to the V. S. the M. W. shall say:

M. W. V. S. what are the duties of the M. W?

V. S. To preside with impartiality; see that all mandates are faithfully executed. In cases of emergency, where no law exists, to use his best judgment for the in-

705 From the *Adelphon Kruptos*, secret ritual of the Knights of Labor, courtesy of Terence V. Powderly



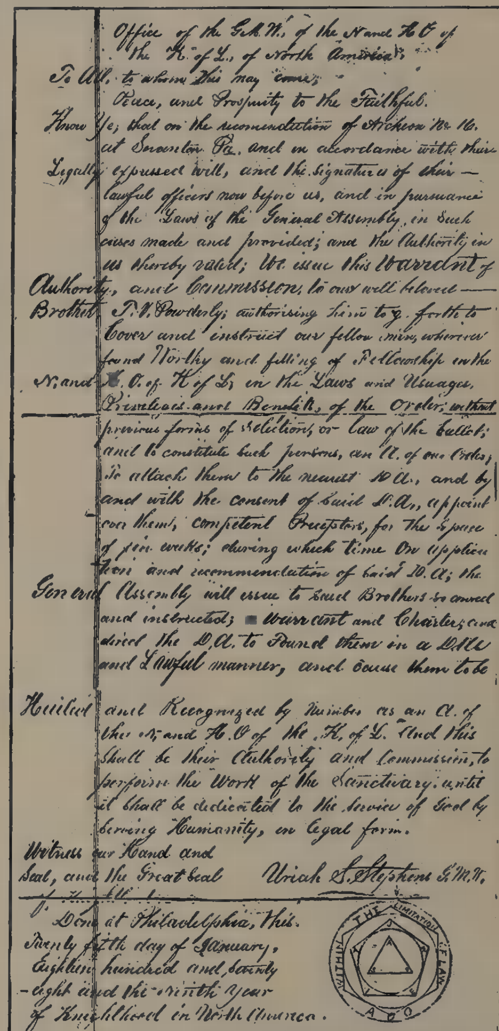
706 From a photograph taken in May, 1886, courtesy of Terence V. Powderly

TERENCE VINCENT POWDERLY, 1849–1924, OUTSTANDING LEADER OF THE KNIGHTS

In 1878, when the Knights of Labor came out into the open, Terence V. Powderly was made its head because Stevens felt himself too old to bear the executive burdens of the revised Knights. Powderly was a machinist by trade and twice mayor of Scranton, Pennsylvania, on a labor ticket.

Under Powderly the Knights attained their greatest power. With secrecy abandoned the order grew by leaps, so that by 1886 it claimed upward of a million members. Jay Gould was forced to negotiate with Powderly and the Knights, this being the first time an American labor organization had brought a prominent capitalist to terms. The Knights, too, stood for Congress and influenced legislation. America had never known such a powerful labor organization.

The organizer's commission issued to Terence V. Powderly has an interest in view of the part played by Powderly in the affairs of the Knights of Labor. There had been no labor leader equal to Powderly up to his time.



Office of the G.M.W. of the N. and H.O. of the K. of L., of North America;

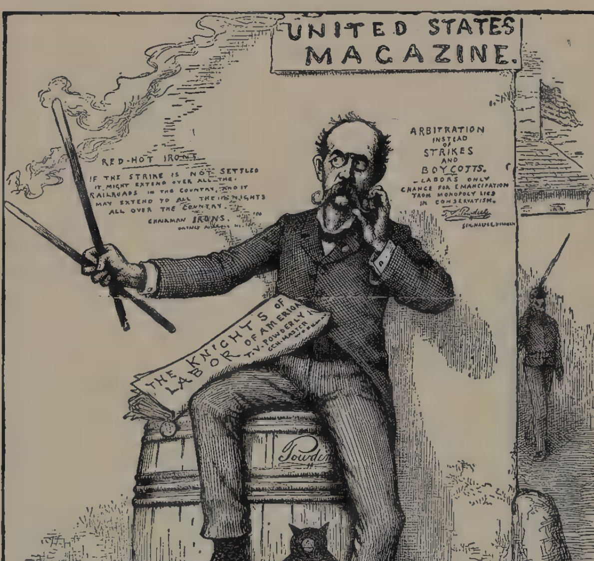
To All, to whom this may come;
Peace, and Prosperity to the Faithful.
Know Ye; that on the recommendation of Archeon No. 16. at Scranton Pa. and in accordance with their Legally expressed will, and the signatures of their lawful officers now before us, and in pursuance of the Laws of the General Assembly, in such cases made and provided; and the Authority in us thereby vested; We issue this Warrant of Authority, and Commission, to our well beloved Brother, T. V. Powderly; authorising him to go forth to Cover and instruct our fellow men, wherever found Worthy and felling of Fellowship in the N. and H.O. of K. of L. in the Laws and Usages, Privileges and Benefits, of the Order; without previous forms of selection, or law of the ballot; and to constitute such persons, an A. of our Order; To attach them to the nearest D.A., and by and with the consent of said D.A., appoint over them, competent Preceptors, for the space of six weeks; during which time On application and recommendation of said D.A. the General Assembly will issue to said Brothers so covered and instructed; Warrant and Charter, and direct the D.A. to Found them in a Due and Lawful manner, and cause them to be Hailed and Recognized by Members as an A. of the N. and H.O. of the K. of L. And this shall be their Authority and Commission, to perform the Work of the Sanctuary, until it shall be dedicated to the Service of God by serving Humanity, in legal form.

Witness our Hand and Seal, and the Great Seal

Uriah S. Stephens G.M.W.

Done at Philadelphia, this Twenty fifth day of January, Eighteen hundred and seventy-eight and the ninth year of Knighthood in North America.

707 First Organizer's Commission issued by the Knights of Labor to Terence V. Powderly, courtesy of Terence V. Powderly



708 From *Harper's Weekly*, April 10, 1886, cartoon by Thomas Nast

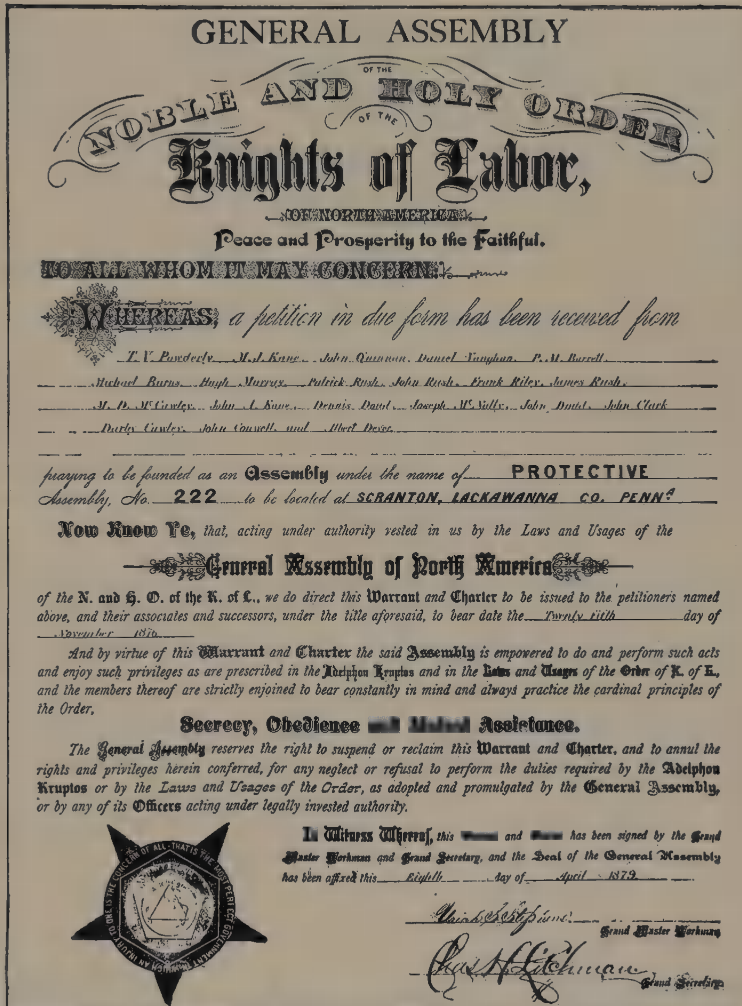
TACTICS OF THE KNIGHTS OF LABOR

The Knights and their officers received more publicity than any labor organization had known up to that time, some of it laudatory but much of it condemnatory. Powderly himself was a conservative man who disbelieved in strikes or boycotts and wished to educate the masses for a distant day when universal coöperation could be applied. But many of his subordinate officers worked for immediate benefits for the workers and seized any weapon available — terrorism, boycott or strike, to gain their ends. This internal dissension was played upon by the press. Among the leaders who consistently opposed Powderly was Martin Irons of St. Louis.

DECLINE OF THE KNIGHTS OF LABOR

Like many another organization the Knights, founded in idealism, ended in radicalism. The founders chose as their motto: "That is the most perfect government in which an injury to one is the concern of all." A quotation from Burke made up their preamble: "When bad men combine, the good must associate, else they will fall, one by one, an unpitied sacrifice in a contemptible struggle." Starting with such noble declarations, the Knights built up a central organization having great power over the policies and program of the order. The Knights of Labor was bound to fail, for at the base it was a polyglot mass of locals whose membership in general was made up of a mixture of workers in many trades and occupations and at the top there was an almost autocratic national control.

In 1886 Chicago anarchists threw a bomb into a platoon of police. Seven anarchists were sentenced to be hanged for this slaughter. The Knights asked clemency for these murders, then withered before a fiercely hostile public opinion.



GENERAL ASSEMBLY

OF THE NOBLE AND HOLY ORDER OF THE

Knights of Labor,

OF NORTH AMERICA.

Peace and Prosperity to the Faithful.

TO ALL WHOM IT MAY CONCERN:

Whereas, a petition in due form has been received from T. V. Powderly, M. J. Kane, John Quinnan, Daniel Vaughan, P. M. Burrell, Michael Burns, Hugh Murray, Patrick Rush, John Rush, Frank Riley, James Rush, M. D. McCawley, John A. Kane, Dennis Dowd, Joseph McNally, John Dowd, John Clark, Darby Cawley, John Connell, and Albert Dexer,

praying to be founded as an Assembly under the name of PROTECTIVE Assembly, No. 222 to be located at SCRANTON, LACKAWANNA CO. PENNa

Now Know Ye, that, acting under authority vested in us by the Laws and Usages of the

General Assembly of North America

of the N. and H. O. of the K. of L., we do direct this Warrant and Charter to be issued to the petitioners named above, and their associates and successors, under the title aforesaid, to bear date the Twenty fifth day of November 1878.

And by virtue of this Warrant and Charter the said Assembly is empowered to do and perform such acts and enjoy such privileges as are prescribed in the Adelphon Kruptos and in the Laws and Usages of the Order of K. of L., and the members thereof are strictly enjoined to bear constantly in mind and always practice the cardinal principles of the Order,

Secrecy, Obedience [redacted] Assistance.

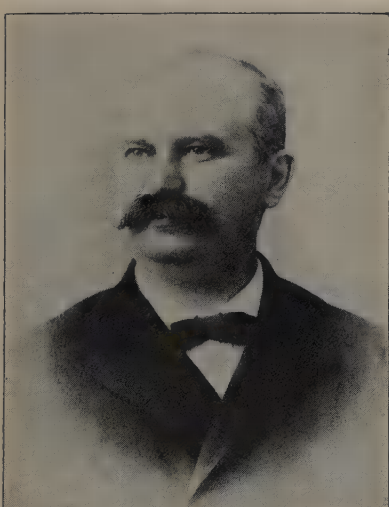
The General Assembly reserves the right to suspend or reclaim this Warrant and Charter, and to annul the rights and privileges herein conferred, for any neglect or refusal to perform the duties required by the Adelphon Kruptos or by the Laws and Usages of the Order, as adopted and promulgated by the General Assembly, or by any of its Officers acting under legally invested authority.

In Witness Whereof, this [redacted] and [redacted] has been signed by the Grand Master Workman and Grand Secretary, and the Seal of the General Assembly has been affixed this Eighth day of April 1879.

Uriah S. Stephens
Grand Master Workman

Chas. H. Litchman
Grand Secretary

709 Charter of a Local Assembly, courtesy of Terence V. Powderly

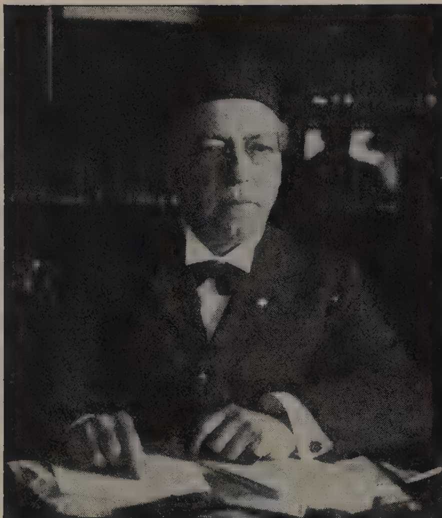


710 Adolph Strasser, from a portrait in the office of the American Federation of Labor

FORMATION OF THE AMERICAN FEDERATION OF LABOR, 1881

The Knights of Labor rose swiftly into power, burst into glory by successful railroad strikes in the 'seventies and 'eighties and then vanished. Disunity, disastrous strikes, disappointing political ventures, discredited leadership, all these weakened the order, but it was finished by a fight for supremacy with a vigorous young craft union later famous as the American Federation of Labor. Powderly himself became a member of the Machinist Union and later for years held a minor office in the American Federation of Labor.

This trade union was formed in part from disgruntled units of the Knights by Adolph Strasser and Samuel Gompers, who had previously worked as cigar makers and had successfully organized that craft. Strasser was the older, wiser head teaching the younger Gompers. The lessons they had learned, by experience in their own craft organization and by observation of the faults of the Knights, they incorporated into the Federation. Gompers kept the Federation consistently an economic organization, opportunistic rather than visionary. He believed the strike, if judiciously used, to be labor's best weapon. He zealously kept the Federation out of direct politics, and he made it a coördinating body, leaving to the various trade nationals almost complete autonomy in their own affairs.



711 © Underwood & Underwood

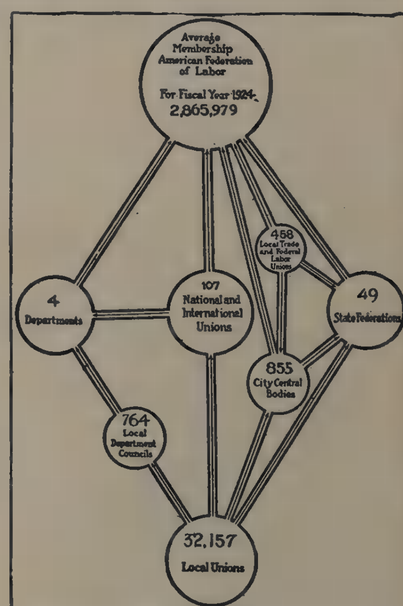
SAMUEL GOMPERS, 1850–1924

Samuel Gompers, president of the American Federation, since its organization in 1881, except for one year, was born in London, the son of Jewish parents of Dutch origin. Brought up on New York's "East Side," Gompers learned and practiced the trade of cigar maker. In his youth he was an avowed Socialist, but when he achieved responsible position, he ceased to be a follower of Marx. He came to fear the movement with its radical program and its ever recurring internal dissensions. He saw in Socialism a menace that might easily thwart his lifelong object of creating a stable and powerful national labor organization. So the Socialists in their many attempts to bring American labor under the red flag always found Gompers their tireless, aggressive and successful opponent. Gompers gave the American labor movement a brain, a soul and a clenched fist. He must be ranked among the great executives of his time.

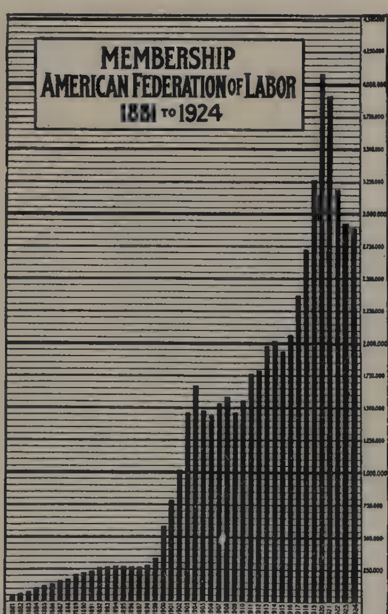
STRUCTURE OF THE AMERICAN FEDERATION OF LABOR

The basis of the American Federation of Labor is the membership of individuals who compose the thirty-two thousand local unions, each of which is separated according to craft. Each craft has its own national union organization. It is this national organization that is affiliated with the American Federation of Labor. Where there are a number of different craft local unions in one city they federate for local purposes into city central unions. Likewise for the state there is a state federation. In towns too small to have more than seven craftsmen of the same trade, local unions may be formed by direct affiliation with the American Federation of Labor. These are called Federal Labor Unions and have, of course, mixed membership. Likewise seven tradesmen may form a local and if no national exists in the trade may be joined directly to the American Federation of Labor.

To facilitate its work and further the cause of federation the Executive Council has connected with itself four departments. These are (1) Building Trades, (2) Metal Trades, (3) Railway Employees, and (4) Union Label department. Some of the departments dealing with complex industries, such as the Building Trades department, subdivide their work into districts so that there may be a District (or local) Department Council.



712 Courtesy of the American Federation of Labor



713 Courtesy of the American Federation of Labor

GROWTH OF THE AMERICAN FEDERATION OF LABOR

The paid-up membership in the American Federation of Labor shows some fluctuation. Business depressions weaken and business prosperity strengthens the membership. The peak of membership was reached two years after the close of the World War, when over four million were enrolled. Following this, over a million members dropped out.

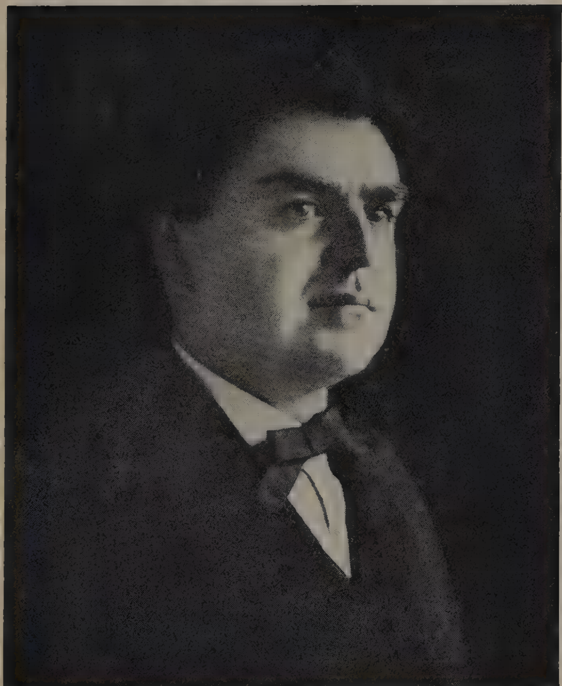
FORMATION OF THE UNITED MINE WORKERS OF AMERICA

In 1886 the coal miners in the Central Competitive Field formed a new kind of labor organization differing from the labor union and the trade union. This novel group called themselves the United Mine Workers, and its membership was not limited to actual skilled miners but included every person engaged in any of the work of coal mining. The union made little headway until 1897, when a general strike in soft coal mines was called. Coming at the beginning of a trade revival, the strike after twelve weeks gained for the workers twenty per cent increase in pay, an eight-hour day, the abolition of the company store and recognition of the union as bargaining agent for the men. The next year the "check off" was obtained, by which the mine operators deducted union dues or assessments from the miners' pay envelopes, thus acting as collectors for the union.

This sweeping victory started the United Mine Workers on the path of success. The organization has since captured every important soft coal field save that of West Virginia, and some scattered operations in various fields. The anthracite operators, being fewer and stronger, resisted the United Mine Workers until 1902, when the operators began to give way. The union did not gain complete sway in this portion of the coal industry until the World War.


714 John Mitchell, 1870–1919. © Underwood & Underwood

The organization is now the largest and strongest union in the United States. Its first great leader was John Mitchell, a vigorous fighter yet a wise councilor. He ranked at the time of his death as one of the greatest labor leaders in America and perhaps in the world.


715 John L. Lewis, 1880–. © Clinedinst

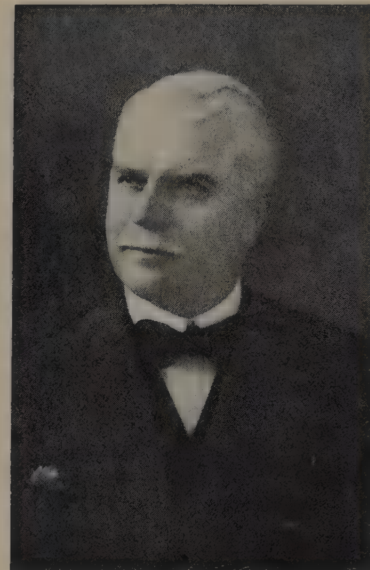
STRENGTH OF THE UNITED MINE WORKERS

Mitchell's successor as leader of the United Mine Workers was John L. Lewis. Under his aggressive command the miners, better than any other group of workers, kept and continued the gains made during the World War. But this success, gained by strikes and threats, aroused the public and has led to public investigations and many plans to bring order into the chaotic coal industry. Since 1923 no union has been under greater fire than the United Mine Workers, and no leader subjected to greater internal and external pressure than Lewis.

As coal is a basic factor in American industrial life, any weakness in the organization of the coal industry has its effect on the entire industrial superstructure. It may be that the time is not far distant when the people of the United States will undertake to put an end to the almost chronic wars of the coal fields.

716 William G. Lee, 1859–. © Harris & Ewing

717 A. B. Garretson, 1856–. © Harris & Ewing



718 Warren S. Stone, 1860–1925, from a photograph by Bushnell

THE RAILROAD BROTHERHOODS

A UNIQUE group of unions is found among railroad workers. "The Big Four" comprises the Brotherhood of Locomotive Engineers, the Order of Railway Conductors, the Brotherhood of Firemen and Enginemen, and the Brotherhood of Railway Trainmen. These were formed originally as mutual insurance and benefit societies to fill a need left untouched by ordinary insurance agencies because of the unusual risks of the trades. During the 'eighties, 'nineties and early years of the present century, the brotherhoods were noted for their conservatism and disinclination to strike. But about 1906 a new attitude was assumed. The railroads, hedged about closely by public authority, could not easily pass on to shippers the cost of the privileges granted to trainmen. On the other hand, mounting costs of living burdened the trainmen, who, failing to gain demands by negotiation, resorted to fighting tactics. This caused them to drop their old aloofness from the regular labor movement. Although they have maintained their policy of "no entangling alliances," they act in close sympathy with the American Federation of Labor. William G. Lee was the president of the Brotherhood of Railway Trainmen when it joined with the other brotherhoods to force the Adamson Act from Congress. A. B. Garretson was then the president of the Order of Railway Conductors. Warren S. Stone, chief of the Brotherhood of Locomotive Engineers, was also the president of the bank owned and operated by the engineers — the first to be owned by a labor union.

719 © Ewing Galloway

THE RAILWAY SHOP WORKERS

BESIDES the trainmen there are two other groups of railway workers, namely, the shop workers and the miscellaneous clerks, telegraphers, switchmen, waymen and shop laborers. The organizations in these groups have never been allied to the brotherhoods; the latter refused to be weakened by them. Having no strategic power of their own the groups have met with little success in wresting privileges from the railroads. The shop workers emerged first, having seven unions to represent them. Of these the strongest has been among the machinists. In 1904 the shop workers banded together by railway systems and in 1912 the various systems were federated. This organization, competing with the Railway Employees department of the American Federation of Labor, organized in 1908, was absorbed by it. The miscellaneous group had no unions of note until the World War, when they attained considerable power under government operation of the railroads. The group has since had a severe struggle to maintain its organization. The cloak of the American Federation of Labor is thrown over them too, for they are included in the Railway Employees department. Without this protection most of them would soon pass away.

THE AMALGAMATED CLOTHING WORKERS

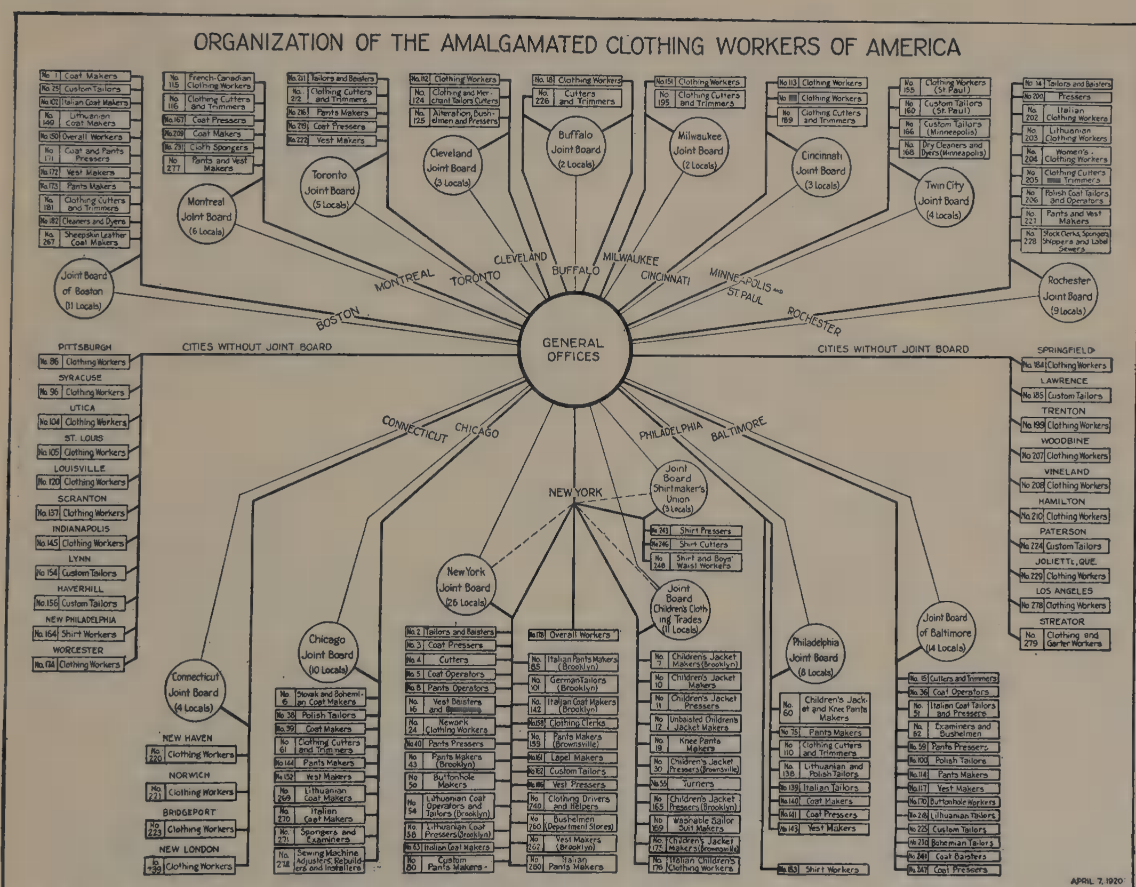
Prior to 1910 the needle workers were organized into a multiplicity of craft unions which were largely ineffective. A strike in 1910 in the Chicago plant of the Hart, Schaffner and Marx Company caused that company to set up a new policy of labor management that has kept the company free of strikes ever since, even in the hectic days of the World War. In the strike and after it the spokesman for the workers was Sidney Hillman, an educated Russian Jew of rabbinical descent.

Hillman observed that the needle trade unions were well-nigh powerless, and his experience convinced him that the proper form of organization was the industrial union. Succeeding in organizing the employees of the Hart, Schaffner and Marx Company, Hillman turned to other clothing centers.

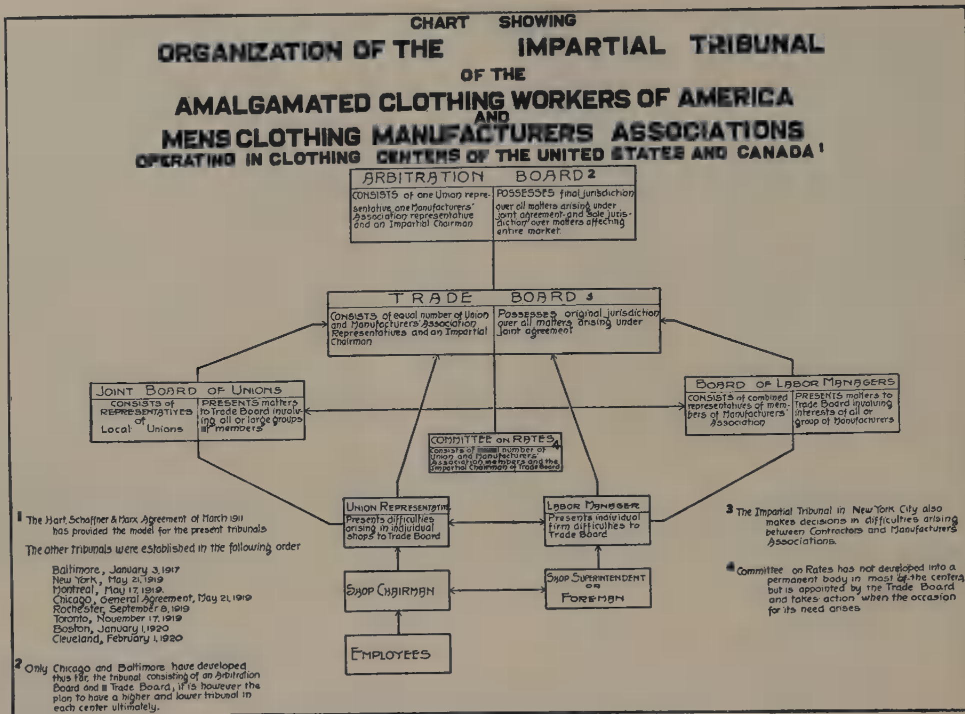
Before the World War he had accomplished a considerable degree of organization for the Amalgamated Clothing Workers of America in New York and Chicago. The war proved to be his golden opportunity; his organization emerged from that conflict in almost complete control of the workers in the men's clothing trade, not only in New York and Chicago but in Rochester, Baltimore, Philadelphia and Boston.

720 Sidney Hillman. © Keystone View Company

The Amalgamated Clothing Workers as a union has never affiliated with the American Federation of Labor; in fact, by that body it is considered a secessionist outlaw organization. Many and bitter conflicts between the two or their subordinate parts have taken place.



721 Courtesy of the Amalgamated Clothing Workers of America



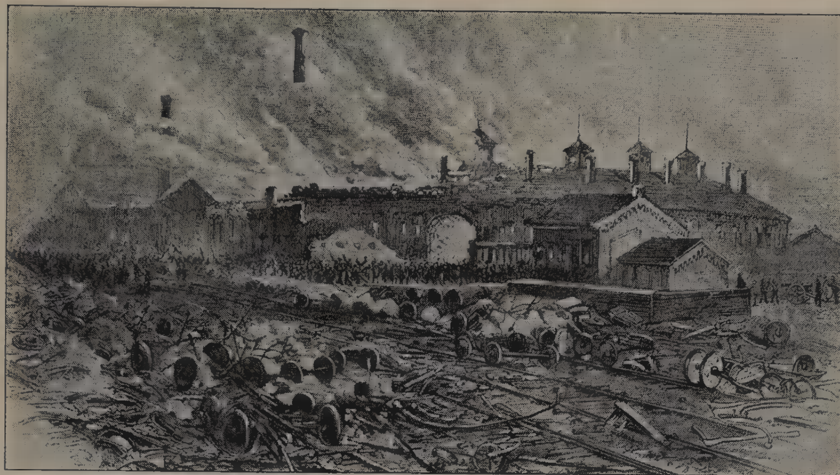
722 Courtesy of the Amalgamated Clothing Workers of America

ARBITRATION BOARDS OF THE AMALGAMATED CLOTHING WORKERS

Having gained control of the workers in the men's clothing trade partly by the old rule of force, Hillman sought to consolidate it by a new policy of peaceful negotiation. The employers of each trade center were organized and then united on a national scale. With these bodies Hillman set up joint tribunals and impartial boards of appeal to deal peacefully with all labor matters. The idea was an enlargement of the scheme of the Hart, Schaffner and Marx Company, that had since 1910 so admirably stood the test of experience. Although some of the employers in New York City have abandoned the plan and some employers in other cities have never had a part in it, most of the men's clothing industry is now operating under it. A Trade Board examining a witness is shown in session (No. 723). Representatives of both the firm and of the union are present. The plan has been extended to many industries, but most of them do not adopt the judicial features and use of precedent in deciding cases that mark the clothing industry.

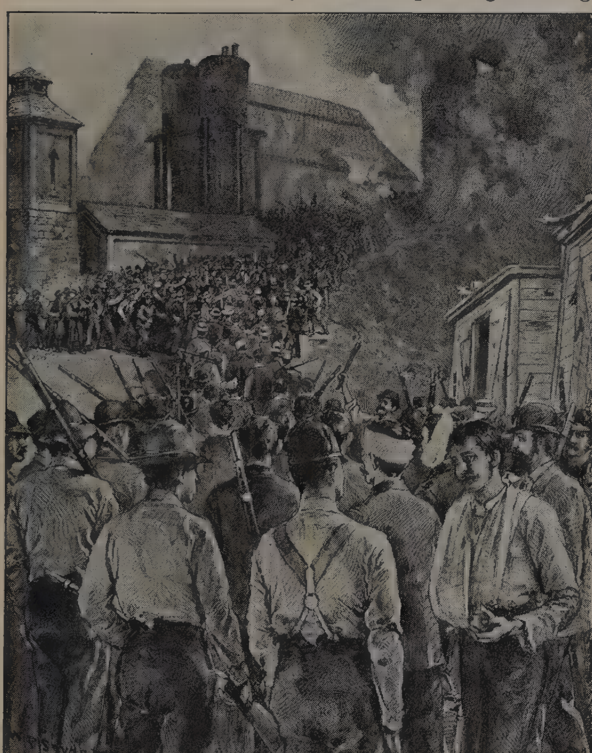
723 Trade Board at the Hart, Schaffner and Marx Company. © Kaufman & Fabry. Courtesy of the Amalgamated Clothing Workers of America

THE RAILROAD STRIKE OF 1877



724 Strikers Rioting at Pittsburgh, 1877, from *Harper's Weekly*, Aug. 11, 1877, after a sketch by J. W. Alexander

ORGANIZED labor's principal weapon is the strike. The causes of strikes are disputes over wages, hours, working conditions, union recognition in collective bargaining, union rules or regulations and union jurisdiction. The apparent failure of about half the strikes does not lessen their value in unionist opinion. If a strike produces any favorable action on a vital issue the unions consider the strike a success regardless of how many of their published grievances remain unsettled. Many strikes, too, are considered as battles in a long campaign. If the latter is won, occasional battles are well lost. Strikes also are means of advertising, strengthening or hardening union forces. The unions know that no other means has brought them so many or such valuable results as the strike, so they resist any and all efforts to curtail it, and oppose all substitutes. The first great strikes were connected with the railroads in the 'seventies and again in the 'eighties. Baltimore, Altoona, Cincinnati and other terminal or junction points were scenes of serious riot and violence. Perhaps the worst strike outbreaks were in Pittsburgh in 1877, where the strikers held the militia in siege and destroyed hundreds of thousands of dollars of railway property. These railway strikes were the occasion for the first use in the United States of troops to put down worker disturbances and led to the system of armories throughout the country. The strikes caused a revival of trials for conspiracy and opened the way for other judicial weapons against organized labor. On the side of labor the strikes advertised the wrongs under which labor suffered, and jolted American complacency. All workers were made to realize, too, that they had common problems calling for joint effort to redress.



725 Surrender of the Pinkertons at Homestead, from *Harper's Weekly*, July 16, 1892, after a photograph by Dabbs

THE HOMESTEAD STRIKE, 1892

THE first great industrial strike was the Homestead strike of 1892. H. C. Frick had, shortly before, entered the Carnegie group and played an active part in the proceedings. A revision of the wage scale resulting in a general raise of pay for most of the workers was opposed by a certain group of "tonnage bosses" who suffered. These men induced the mass of the workers to rally to their support and the strike was on. During the strike the company employed Pinkerton detectives as armed guards and there was one pitched battle between these guards and the strikers. There was an attempt also to assassinate Frick. Eventually soldiers were called in to keep order.

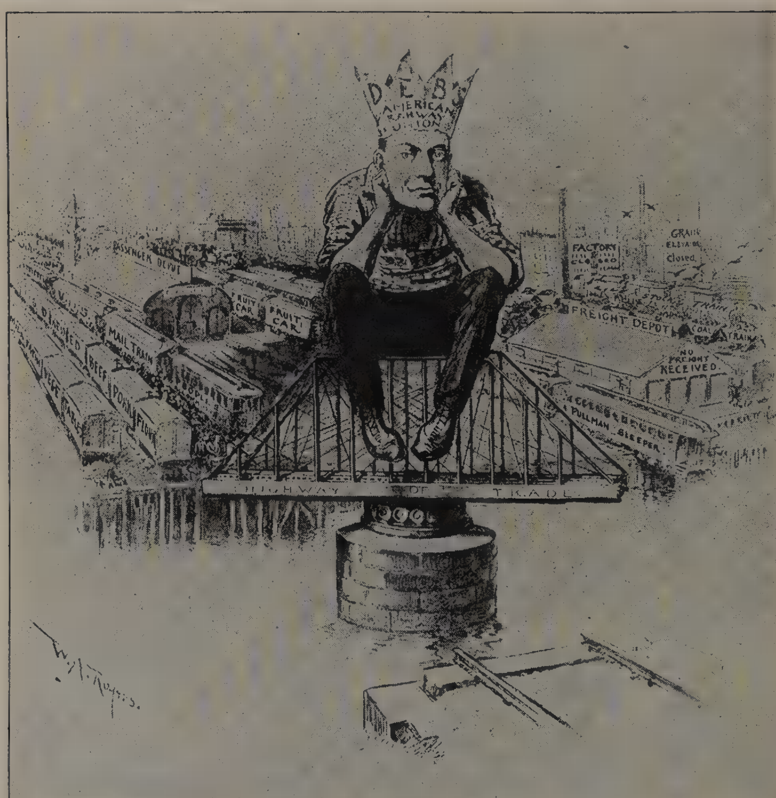
Organized capital beat organized labor, and the steel industry saw no other great effort on the part of organized workers for a quarter of a century, when another great strike was lost to the workers, but so aroused public opinion that the steel industry was compelled to reduce its hours of work.

726 United States Regulars Guarding the Meat Trains at Chicago, from *Harper's Weekly*, July 28, 1894, drawing by G. W. Peters, after a sketch by G. A. Coffin

THE PULLMAN STRIKE, 1894

The Pullman strike of 1894 grew out of a demand by the Pullman employees for a restoration of wages paid before the panic of 1893. These employees had joined the American Railway Union, of which Eugene Debs was the head, and the union had just emerged successfully from a contest with the Great Northern Railway. This union took the strike out of the hands of the Pullman employees and declared a sympathetic strike against all roads entering Chicago that handled Pullman cars.

This strike has its place in history because it was the first attempt in America to use the revolutionary strike methods of Europe — and it failed. It was also the first important use of the injunction by employers to stop or hinder a strike. Debs was jailed for violating this injunction.



727 From *Harper's Weekly*, July 14, 1894, cartoon by W. A. Rogers

728 Troops Defending the Lawrence (Mass.) Mills. © Brown Brothers

THE LAWRENCE TEXTILE STRIKE, 1912

VIOLENCE is a familiar accompaniment of strikes, for whenever the workers quit they are usually determined that others shall not take their places in the shop. So collisions occur. A great strike is so apt to pass beyond police control that militia troops are commonly called out to restore and maintain order. It appears that violence in strikes is not decreasing. If unions cover more industries and wider territories and if more unskilled men are included in the unions, it seems that the strikes of the future will not only be more general in scope but may be more rather than less violent. The Lawrence strike of 1912 was notorious for the violence of both sides.

729 © Keystone View Company

PICKETING

ONE of the features of strikes is picketing; that is, the prevention by the strikers of workers substituting in the strikers' jobs. Such substitutes are labeled "scabs," "blacklegs" and other epithets.

Picketing may be peaceful, that is, word of mouth persuasion, but it lends itself readily to violence and other forms of intimidation, and it has therefore come under legal condemnation.

THE ROOT OF THE MATTER.

BOYCOTTER. "*You must stop work, because I have a grievance against your employer, no matter whether you have any, or whether your family suffers meanwhile. I must show my power.*"

730 From *Harper's Weekly*, May 8, 1886, cartoon by Thomas Nast

THE BOYCOTT

UNLIKE the strike, the boycott in the hands of labor is less often a useful weapon in modern times than formerly. Practically the unions find it increasingly difficult to organize and carry out an effective boycott. What could be done in a village against a butcher is almost impossible to do in a nation against a packer's corporation. The public, too, cannot justify a boycott, especially one that is indirect, as easily as it can a strike. Without public support labor cannot wield its weapons effectively. The law is severe in condemnation of labor boycotts.

THE WAR LABOR BOARD

WORKERS have organized generally in the past for purposes of aggression but there is evident a new spirit among some employers and employees. Organization is accepted as necessary, but the purpose is to be diverted from war to peace. The attempt is to make adjustments by negotiation rather than strife.

One of the famous boards created for such a purpose was the War Labor Board set up during the World War. This board was made up of representatives of the employers and an equal number of representatives of labor organizations. It had two chairmen, Frank P. Walsh, acting for the workers, and William H. Taft, presiding in the name of the employers. This board drew up a declaration of principles that read like a new Bill of Rights, and then proceeded to settle labor controversies during the war by negotiation rather than by strikes or lockouts. It succeeded far better than either employers or employees had dared to hope. It went out of existence with the end of the war. Its favorable record encouraged efforts to set up peace-time machinery for settling labor disputes without strikes.

731 © Central News Photo Service

732 © Harris & Ewing

THE RAILROAD LABOR BOARD

THE Transportation Act of 1920, passed when the railroads were returned to private ownership after the World War, contained among other things a provision for creating a Railroad Labor Board that would constitute a court of final appeal and adjustment in railroad labor disputes. It is a tripartite board having three members, one each for employers, employees and the public, and serving for five years.

Within three years of its origin the board had dealt with cases involving a billion dollars in wages. Its decisions have angered the railway men and gained the hostility of some of the railway managers. The judges of the regular courts, too, have had to caution the board not to exceed its authority. Although beset on all sides, the board has continued and has received the support of the government under Presidents Wilson, Harding and Coolidge. It is still (1926) on trial, and its future depends largely upon its own prudence.

THE KANSAS INDUSTRIAL COURT

THE Court of Industrial Relations — more commonly known as the Kansas Industrial Court — was created by a special session of the Kansas legislature in January, 1920. Its immediate cause was the soft coal strike of that year but the idea for such a court had been formulating in the minds of certain Kansans for some time.

The law creating the court widened the usual definition of public utilities and then brought all public utilities under the act. It prohibited strikes and lockouts but gave every employer and employee a chance to have his grievances aired and adjusted.

The court was composed of three judges and had all the powers of an ordinary court. Its awards were final except for appeal to the Kansas Supreme Court and penalties have been imposed for violations of its decrees.

The organized unions were opposed to the court because it destroyed their best weapon, the strike, and seemed to make unions useless. Employers at first favored the court until some of its decrees hit them unfavorably. With this united opposition of employers and employees the court has had difficulty in functioning. It was shorn of most of its prestige, too, by the decision of the United States Supreme Court in the Wolff Packing Case, that the definition of a public utility cannot be extended in the manner laid down by the act that created the Court of Industrial Relations. Despite this decision the Kansas Court is looked upon as an important contribution in labor relations and may be the beginning of a new method of settling industrial disputes.

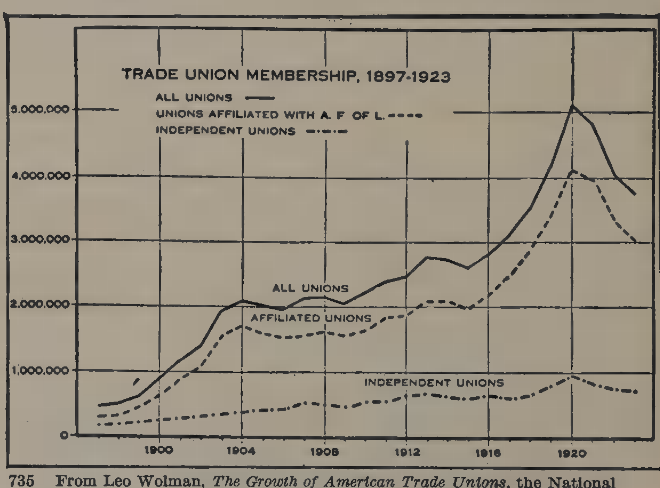
733 Courtesy of *The Christian Herald*, New York

Group	1897	1900	1910	1914	1920	1923
All Groups	100.0	100.0	100.0	100.0	100.0	100.0
Transportation	26.1	21.8	22.0	20.7	24.6	25.1
Building	15.0	17.6	21.0	20.0	17.4	22.3
Metal, Machinery and Shipbuilding	11.2	9.3	9.0	8.3	16.8	9.5
Food, Liquor and Tobacco	9.9	7.6	5.3	5.0	2.3	2.3
Paper, Printing and Bookbinding	8.5	5.5	4.1	4.1	3.2	4.0
Chemical, Clay, Glass and Stone	5.2	3.5	2.8	2.1	1.0	1.2
Mining and Quarrying	4.7	15.0	12.6	14.0	8.2	11.0
Leather	3.4	1.1	2.1	2.1	2.2	1.9
Clothing	3.3	2.9	4.4	5.8	7.1	8.2
Public Service	2.5	1.8	2.7	3.4	3.2	4.5
Textile	1.8	0.9	0.9	1.1	2.9	1.0
Theatres	1.5	1.1	2.8	3.4	1.9	2.8
Restaurants and Trade	1.4	3.2	2.7	3.5	2.8	1.6
Lumber and Woodworking	1.2	2.9	1.3	0.9	0.5	0.3
Miscellaneous	4.3	5.8	6.3	5.6	5.9	4.3

734 Percentage of the Total Membership in each Unit of Organized Labor, from Leo Wolman, *The Growth of American Trade Unions*, the National Bureau of Economic Research, 1924

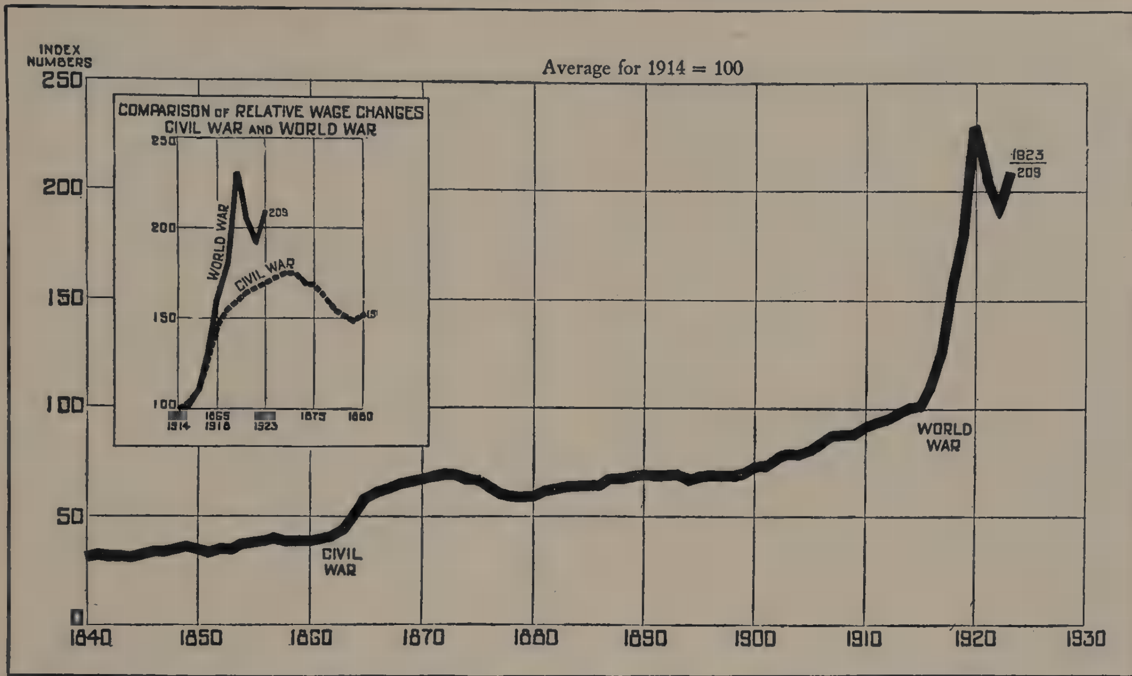
THE STRENGTH OF ORGANIZED LABOR

It may be asked fairly, "What has the labor movement accomplished," or "Has the labor movement succeeded?" To make satisfactory reply to these queries requires a measurement of the deeds of the labor movement against its aims. How nearly has it approached its goals? From the beginning it has been one of the objects of labor leaders to include in the movement all the wage earners of the United States. Union membership figures indicate two peaks,* one in 1887, when a total of about a million persons were enrolled of whom about three fourths were in the Knights of Labor; the other in 1920, when the five million mark was reached, four fifths of whom were in the American Federation of Labor. At that time about one fifth of all the wage earners were in unions. Unionism found its earliest strength among the highly skilled or among workers whose positions were so unique that they could exert unusual pressure upon employers. Thus unions were at their best among the railway trainmen, the building craftsmen, coal miners, glassworkers and stonecutters. Since 1915 the union organization has spread rapidly among the semiskilled and even among the unskilled. Among women workers, too, who before 1910 were relatively insignificant in union ranks, organization has progressed at a rapid rate. Among the chief divisions of all wage earners, organization has made the least impression in domestic and personal service, where but three per cent of the total number are enrolled in unions. At the other extreme it is found that thirty-seven per cent of all persons employed as wage earners in connection with transportation are in unions and forty-one per cent of all the wage earners engaged in the extraction of minerals. In any one chief division of wage earners such as the group engaged in manufacturing and mechanical pursuits, variations within the group are enormous, whereas the division as a whole shows twenty-three per cent organized. Thus in this group the workers in chemical plants are only one per cent organized while workers in clothing are fifty-seven per cent organized. However, it is evident that the unions have gone a long way toward the first aim of including all wage earners in worker organizations.



735 From Leo Wolman, *The Growth of American Trade Unions*, the National Bureau of Economic Research, 1924

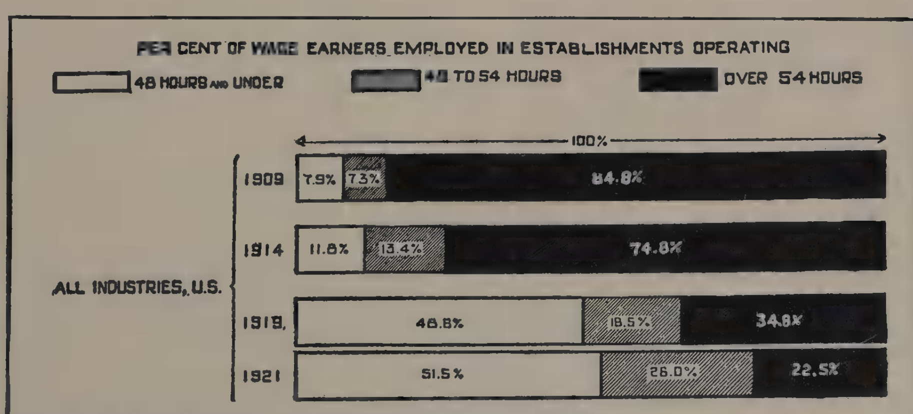
* Data from Leo Wolman, *The Growth of American Trade Unions*, the National Bureau of Economic Research, 1924.



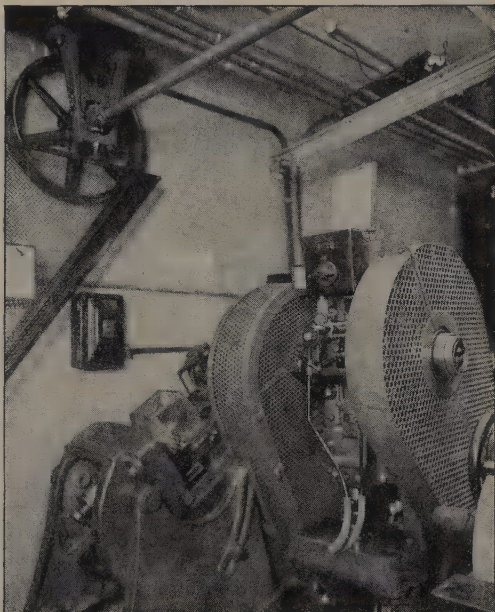
736 Trend of Wages, 1840–1923, from *Wages and Hours in American Industry*, National Industrial Conference Board, 1925, supplemented by data from the United States Bureau of Labor Statistics

IMPROVEMENTS IN WAGES AND HOURS

Not only to include all wage earners in unions but to hold the gains of prosperity in times of depression has been the aim of labor leaders. Before the American Federation of Labor was formed, union membership and success in bargaining varied directly with business conditions; triumphant with good times, debased in bad. Partly by a policy of high dues with consequent high benefits, the Federation has been able to modify previous experience. The depression of 1893 was weathered, the panic of 1897 was not only passed through without ultra-serious loss of membership and prestige, but some unions were able to prevent undue wage-slashing or wholesale discharges. The aftermath of war, felt in business in 1921, saw the unions militant, defying a loss of war-won wage rates. One of the largest unions, the United Mine Workers, succeeded in keeping the war wage intact, while many unions prevented serious cuts. As with wages, so with other union privileges such as regulation of hours, or collective bargaining. The organizations are now powerful enough to prevent employers, in periods of business slough, from cutting away deeply the advances made by unions when business is climbing the peaks. To the degree that unions have done this and from their point of view, they must be credited with success.



737 Prevailing Hours of Work in Manufacturing Industries, 1909–21, from *Wages and Hours in American Industry*, National Industrial Conference Board, 1925, from data in the United States Census of Manufactures, 1921

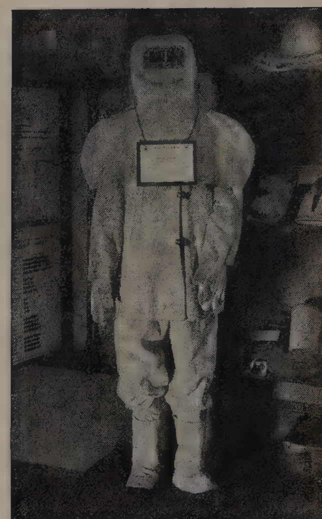


738 A Machine Guarded to Prevent Accident, courtesy of the American Museum of Safety, New York

IMPROVEMENT IN WORKING CONDITIONS

A THIRD way of gauging the success of unionism is by ascertaining how much they have improved working conditions. A great deal has been done by direct union pressure upon employers but the greatest achievements in raising working standards have come through legislation. To be sure the unions alone and unaided have not been responsible for all the laws that have aided labor, for many other groups have been sponsors equally of these efforts, but the unions have been the most insistent and persistent advocates of measures that would ameliorate the condition of workers.

The legislation that has been secured is too diverse and too great in aggregate to be listed, but suggestions of the whole may be obtained by mentioning the laws limiting the hours of work, setting minimum wages, compelling safeguards against injury or disease, establishing an employers' liability and organizing workmen's compensation in cases of accident, sickness or death. Other insecurities and risks that indirectly affect working conditions and have been the subject of industrial legislation are unemployment, old age, the priority of wage claims in cases of bankruptcy, and the restriction of child immigration and prison labor.



739 Asbestos Clothing for Hazardous Work, from an exhibit in the American Museum of Safety, New York

LABOR IN THE COUNCILS OF THE NATION

BY some union men, and directly by some unions, it is asserted that the aim for labor is to control industry. The degree of control desired varies from having a voice in those matters, such as wages and hours, that are of special interest to labor, to entire administration of an industry; a goal that is announced in the constitution of the Amalgamated Clothing Workers.

In line with these objectives the Brotherhoods and Amalgamated Clothing Workers have set up a score of labor banks to use the tools of capitalism to further the cause of labor. The establishment of the closed shop is in many instances a step in the direction of greater control of industry by labor. The Plumb Plan of the railway trainmen, and the nationalization ambitions of the United Mine Workers were balloons sent up to gauge the drift of labor feeling and public opinion about giving labor a more important share in industry. A labor representative in the President's cabinet, the Secretary of Labor, and labor members on boards and commissions such as the Railway Labor Board, are evidences of labor power and measurably increase labor's control of industry. Although labor is a long way from complete administration of industry in labor's interest, it is much nearer this goal since unions have become strong.

740 President Coolidge and Cabinet, 1924. © Underwood & Underwood

The dictum that "all men are born equal" is merely the expression of an ideal; it is a test and guide of action; in the modern vernacular, it is the "square deal." But from Aristotle down, it has been recognized that men's capacities differ, and since society requires a great many different kinds of work, it is as well that this is so. Not every individual is so fortunate as to find the right task at precisely the right time, but in spite of tragic misfits, modern society offers something approaching equality of opportunity, both to the stalwart moron and to the invalid.

741 From the painting *The Plowers*, by S. M. Seidenberg in the Toledo (Ohio) Museum of Art. © Detroit Publishing Co.

THE UNSKILLED LABORER

For countless centuries man controlled no force of nature save fire and that found in his own body. Only recently, since science has begun to understand the unwritten records of the years before history began, have modern men become conscious of the vast space of time through which the men of the Old Stone Age struggled to wrest a meager living from nature, literally by their own hands. Yet they lived, had they but known it, in a world charged with energy, born of natural forces which could be tamed and made to serve their ends. Nor, even to-day, have all men advanced much beyond the culture of those ancient peoples, whose tools were of roughly chipped flint and unpolished stone. The scientist in his systematic exploration of the earth has made known many peoples who have advanced but little beyond the Stone Age culture. Industrialism, in fact, is not universal; it is limited to restricted areas. The picture of humankind dragging a crude plow through a tough sod symbolizes the part which human muscles have played in life on the earth, from the advent of the race on this planet even to the present time. Noble civilizations, the Egyptians of the Nile valley, the Chaldeans of the Tigris and Euphrates country, the Mayas of Guatemala and Yucatan, have been reared upon the bent backs of human beasts of burden. After all, human muscles are among the most effective forces of nature at man's disposal. The triumphs of industrialism have not destroyed their usefulness.

742 From the mural painting *Labor*, by Charles Sprague Pearce (1851–1914) in the Library of Congress, Washington. © Detroit Publishing Co.

743 From the painting *The Nail Makers*, by Oscar Bjork (1860–) in the Corcoran Gallery of Art, Washington. © Detroit Publishing Co.

THE ARTISAN

To his native equipment of brawn the artisan added knowledge. Mental energy supplemented physical energy and directed it. The picture of the nail makers about their rough stone forge and busy with their crude anvils carries the imagination back to colonial America and to the early years of the republic when the artisan was the chief manufacturer. This was but yesterday in the history of the race, yet how different the life of that time. America was then a country of farms and little villages at the crossroads. On the seacoast small commercial cities were rising. Men worked bravely in their shops shaping with their own hands wood and metals into the articles needed by the folk of the community. Since men first had begun to make tools there had been artisans. These nail makers represented the last stage of a long development. They were soon to disappear with the on-coming of the age of machinery. Their art had done much for the amelioration of human life. The artisan had lifted society high above the plane of the savage. In his day the handworker stood at the forefront of man's struggle with nature. Material progress paced evenly with him. When he passed as a dominant figure, he left a long record of useful achievement and a place forever secure in the history of men.

744 From the series of mural paintings *Labor*, by John W. Alexander (1856–1915) in the Carnegie Institute, Pittsburgh. © Detroit Publishing Co.

745 From the series of mural paintings *Labor*, by John W. Alexander in the Carnegie Institute, Pittsburgh.
© Detroit Publishing Co.

THE AGE OF THE MACHINE

BEGINNING with the Industrial Revolution, the crowning material achievement of Western civilization has been the discovery and the harnessing of the forces of nature. Scarcely more than a century and a half has elapsed since the first textile machines began to alter the industrial life of England. With incredible swiftness man has brought under his control power beyond the wildest dreams of former generations. Eighteenth-century men thrilled with awe when Franklin drew electricity from the storm cloud; to the people of the twentieth century the tapping of the energy of the universe has become a commonplace. They walk with little interest through the factory where hurrying belts drive intricate machines. They look up without wonder at the great gaunt blast furnace belching fire. The factory and the furnace are a part of everyday life. Men and women work in such places for wages, hurrying in when the morning whistle blows. Industry is noisy and dirty; it is full of humdrum tasks. Only rarely does a man catch the vision of its epic quality. Such a man may record his emotion in a picture, a book, or a mighty industrial achievement.

746 From the mural painting *Industry*, by Albert Herter (1871–) in the National Park Bank, New York

INDUSTRIAL AMERICA

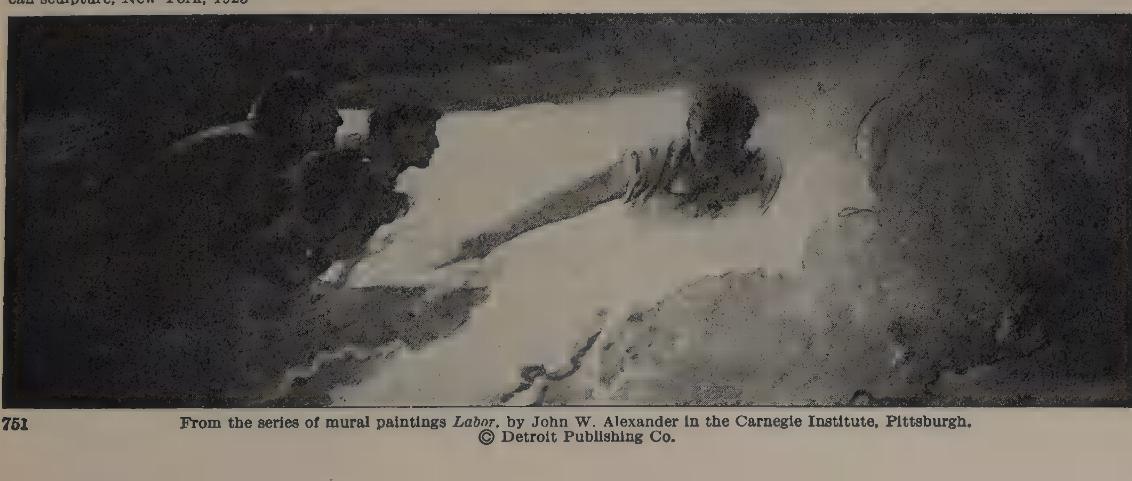
For America, as for every other nation where the machine has become a part of the life of the people, industrialism has meant a break with the past and the advent of a new civilization. The break is not complete. The ideas and the ideals of the earlier day pass over into the new era. So in the United States the individualism and the democracy that so sharply characterized the life of early nineteenth-century America were carried into the turbulent days that have followed the Civil War. But both have been modified sometimes almost beyond recognition. America has become a nation of gigantic cities. A majority of its people now live in an artificial, man-made, urban environment. They are lifted far above the primitive struggle for existence; they strive for a standard of living. With all the struggle life is easier than in the ruder days; the wealth which has flowed from industrial development has made it so. But industrialism has done more than harness the forces of nature; it has helped to release the energy latent within man himself. It has made possible the swift intellectual advance of the modern universities. It has freed the investigator from the pressing need to struggle for a livelihood and enabled him to probe farther and farther into the secrets of nature that knowledge may be augmented and the lot of humankind bettered. And withal it has inculcated the gospel of Work. In the United States the hurrying workman and hurrying executive seem to move in tune with the swift rhythm of countless machines. How different is modern America from the leisurely stagecoach days of Washington and Jefferson! In looking back at that not distant time one remembers that progress from that day to this has been marked by constant acceleration. The man of to-day considers with awe, not unmixed with fear, the possibilities of to-morrow.

747 From the series of mural paintings *Labor*, by John W. Alexander in the Carnegie Institute, Pittsburgh.

748 From the mural painting *Modern Engineering*, 1919, by Fred Dana Marsh (1872–) in the Engineers' Club, New York

749 From the bronze figure *The Stevedore*, by Mahonri M. Young (1877–) in the exhibition of American sculpture, New York, 1923

750 From the mural painting *Modern Engineering*, 1919, by Fred Dana Marsh in the Engineers' Club, New York



751 From the series of mural paintings *Labor*, by John W. Alexander in the Carnegie Institute, Pittsburgh.
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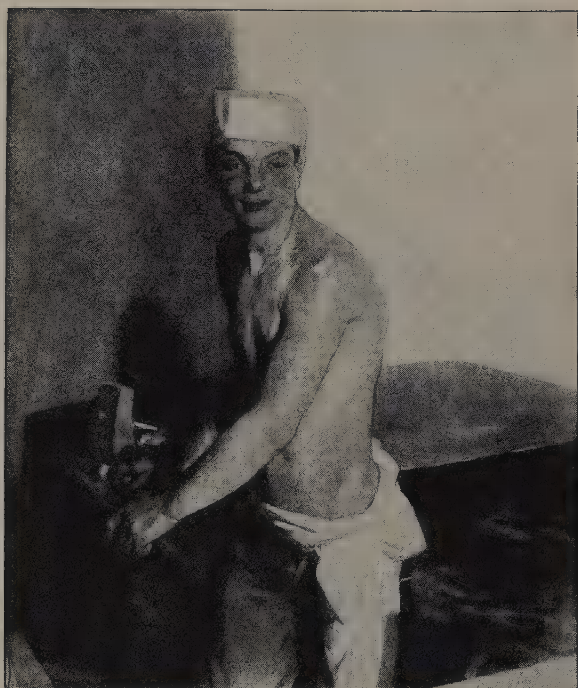
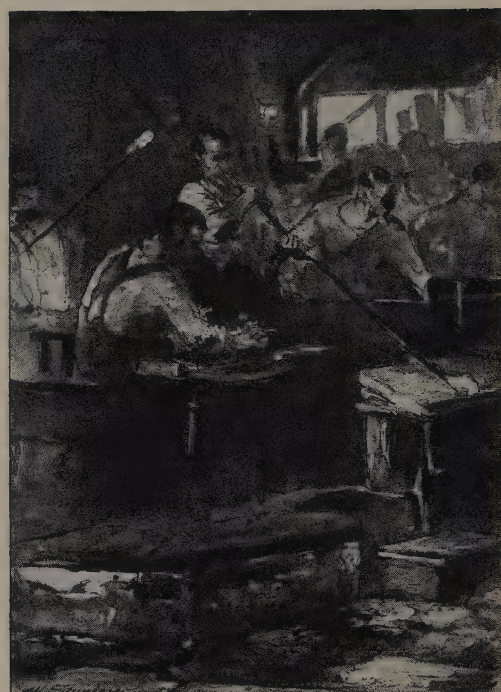
752 From the series of mural paintings *Labor*, by John W. Alexander in the Carnegie Institute, Pittsburgh. © Detroit Publishing Co.



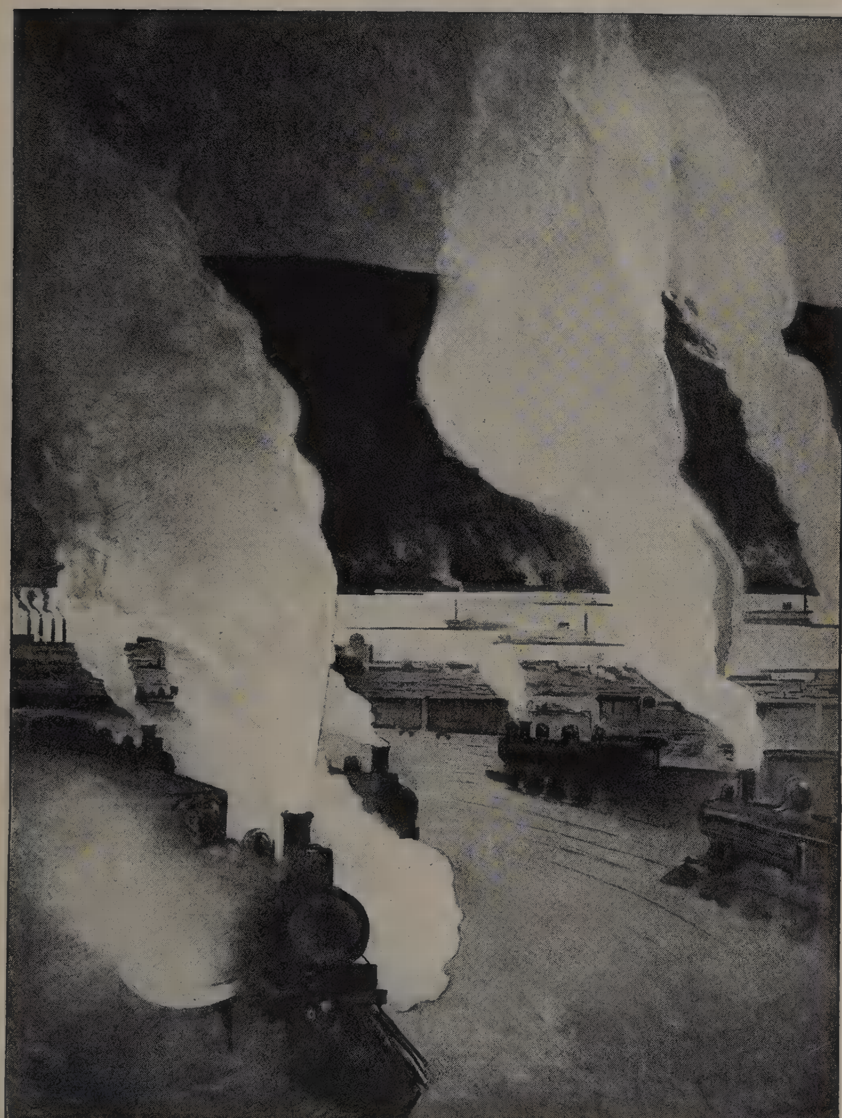
753 From the painting *The Marble Worker*, by Glyn W. Philpot (1889–) in the Hackley Gallery of Fine Art, Muskegon, Mich. © Detroit Publishing Co.



754 From the painting *The Glass Blowers*, by Walter Shirlaw (1838–1909) in the Hackley Gallery of Fine Art. © Detroit Publishing Co.

755 From the series of mural paintings *Labor*, by John W. Alexander in the Carnegie Institute, Pittsburgh. © Detroit Publishing Co.

756 From the series of mural paintings *Labor*, by John W. Alexander in the Carnegie Institute, Pittsburgh. © Detroit Publishing Co.



757 From the series of mural paintings *Labor*, by John W. Alexander in the Carnegie Institute, Pittsburgh. © Detroit Publishing Co.

758 From the sculpture *The Ironworkers*, in front of the Mines and Metallurgy Building, International Exposition, 1900, Paris

NOTES ON THE PICTURES

2. Alden home, built in 1653, since inhabited by nine generations of Aldens. John and Priscilla Alden lived here for several years with their eldest son.
3. Tools are dated about 1770 and belonged to Captain Caleb Clapp.
5. House built by Rev. John Hancock in 1698, enlarged in 1734. It now houses the collection of the Lexington Historical Society. The Society restored the house as far as possible to its original condition.
9. Basin (at right) is of Sheffield plate made in Salem, about 1790. The coffee pot of Britannia ware was made in New England about 1840. The large plate behind it was made in London, 1740–50. Pitcher is early nineteenth century.
10. The two spoons at the right were cast in a wooden mold in 1796.
12. Drawn for the publication issued by the United States Patent Office, 1892, Benjamin Butterworth Commissioner, to illustrate the progressive development of mechanical invention.
13. A porthole at the top is for the removal of the butter.
14. The flintlock tinder box (No. 5) is of the style of 1790.
15. The candle reflector (No. 1) dates from about 1835.
19. See 12.
22. By engraver of remarkable versatility and prolific production, sometimes called the "Father of American engraving."
32. Oliver Evans, an early American engineer and inventor. His book on the construction of water-power machinery was for many years a standard guide for engineers. It contains earliest illustrations of American water-mill machinery. Its engravings were made by James Poupard, born at Martinique, known to have lived in Philadelphia from 1793 to 1807, and who was in New York City as late as 1814. See Nos. 115–119.
34. Reconstruction under the direction of George Francis Dow.
35. Plan of Main Street, Middletown, as it was between 1770 and 1775; made in 1836 by Joseph Barratt, M.D., of Middletown.
40. Originals were used by Deacon Hitchcock, of Deerfield, in 1765.
42. Edward Hazen also wrote *A Practical Grammar of the English Language*, 1844, and *The Speller and Definer*, 1845.

43, 45. See 12.

47, 49, 50, 51, 53. See 42.

54. Sketch is an insert on the map, No. 581, in Volume I.
58. Milbert's drawings of American scenes were from nature, and are reliable.
59. Indenture is dated 1715, and bears impress of a seal and three six-penny stamps.
60. Charles Green Bush, born at Boston in 1842, studied drawing and painting in Boston under William Remmer. Went to New York in the late 'sixties where he worked for *Harper's Weekly*. Later became a famous cartoonist.
61. See 22.
62. One of twelve plates designed and engraved by Hogarth to depict the careers of two apprentices. Plates were first issued September 30, 1747. The series does not appear to have been painted and no originals are recorded. In the Print Room of the British Museum are a set of designs and preliminary sketches made by Hogarth. Thomas Cook was an engraver who became famous by re-engraving the entire set of Hogarth engravings; these were issued in 1806.
65. Joseph Wright, British portrait painter, studied under Thomas Hudson, the master of Reynolds.
68. This machine was used by Crompton in his small mill on King Street, Bolton.
72. According to the present head of the Wetherill family, the original Wetherill was a Quaker and objected to having any picture taken of him. The silhouette was taken surreptitiously, without his knowledge.
73. This record, written in the hand of the original Wetherill, is now in possession of a descendant.
74. According to Stauffer, "The plate was evidently made in connection with the work of the Society for Promoting American Manufactures organized in Philadelphia in 1775. No other engraved work by Tully is known to the enquirer."
75. The copper plate which was used by the original Wetherill for the printing of labels was lost. A proof from the plate still exists and it was from this that the copy used was made.
78. One of a series of sepia cuts made by George Elmer Browne for one of the World's Fairs. Browne a pupil of the School of the Museum of Fine Arts, Boston.
79. Cole, son of French artist who settled at Newburyport, Mass., painted portraits at Boston; among them Hewes, survivor of Tea Party.

80. Pollock was an American engraver, who was working in Providence about 1839. Original of this engraving was a drawing by W. J. Harris, in 1836.
82. Most of the cuts used in White's *Memoir* are copies of cuts that appeared in English books on the cotton industry. Although this one is captioned as a view of Slater's mill, the general character of the other illustrations makes the authenticity of this one doubtful.
85. John Rubens Smith, an engraver, born in England, died in New York. Worked at Boston about 1811 and in 1816 was in New York painting portraits. He taught drawing at Philadelphia about 1835 to 1837, and had among his pupils Sully, Leutze, and Gifford. His design and etching of the monument in St. Paul's Churchyard, New York, to George Frederick Cooke, the actor, attracted attention.
86. Barber's illustrations of places and scenes in New England were faithfully done from observation.
88. Silhouette said to be the only likeness extant of Francis Cabot Lowell.
90. John Cheney, born at South Manchester, Connecticut, in 1801, excelled as a line engraver of small heads.
91. Benjamin Mather, born in Connecticut about 1776, died at Lowell in 1863. At one time was a bookseller and later Superintendent of Scales at Lowell. Painting was presented to the Hamilton Manufacturing Company in 1886.
92. See 86.
94. Original has the inscription "Lithograph of E. W. Bouvé," American engraver about 1840.
96, 97. See 86.
101. See 42.
103. Artist was born at Dublin in 1792 and came to America in 1818. He was a landscape painter and resided for a time at Newport, Rhode Island.
110. Artist born at New York, studied abroad; was a landscape painter and noted for his Long Island scenes. Picture was exhibited at the Centennial Exposition of 1876.
111. View probably a reconstruction; it is signed "Sullivan" as draftsman and "Lovejoy" as engraver of the wood block in *The American Pioneer*, a monthly devoted to Western history.
112. Artist an American landscape painter, born at Rossville, New York. In 1851 became a member of the Academy of Design. Worked abroad 1857 to 1863 and exhibited his "Backwoods of America" at the Royal Academy.
115–119. See 32.
123. Arthur T. Safford is engineer in charge of Locks and Canals at Lowell and has written articles on water power.
131. Hennepin, French explorer, accompanied La Salle on part of his travels. Some of his discoveries were discredited.
137, 139. Both originals are preserved in the files of the Lehigh Coal and Navigation Company, Philadelphia.
138. This early scientific journal, founded in 1818 and edited by Benjamin Silliman (1779–1865), was the first to use lithographs (1821) in this country, soon after the art was perfected abroad. It contained lithographs by Pendleton, one of the American pioneers in this sort of illustration.
144. Pyne's figures and landscapes were "accurately drawn from Nature" and "for the embellishment of the landscape." See Volume III, Nos. 4, 32.
145. Sir Charles Lyell, a famous British geologist, visited the United States in 1841 and again in 1845, studying the formation of beds of coal, the recession of the Falls of Niagara, and the Mississippi delta. He delivered a course of lectures at the Lowell Institute, Boston. Lyell states, "I found at Brownsville a bed ten feet thick of good bituminous coal. . . . I made a hasty sketch of its appearance from the bridge looking down the river."
146. Howe's sketches of places in Middle and Western states were done on the spot, afterwards engraved on wood for his various *Collections*.
148. Chart by a well-known electrical engineer.
156. See 12.
166–167. Artist a well-known illustrator of his day.
171. Frenzeny, American illustrator, contributed to *Appleton's Journal, Harper's Weekly*, and other journals.
180, 181, 183. Photographer specializes on types of industrial workers.
182. See 171.
195. See 171.
210. Few copies of this engraving exist. The print first came to light in London in 1876. A double column description of the plate has been omitted from the reproduction. Two other copies are known to exist, differing from this copy in that the description is in one column at the side. These two are at the reference library in Birmingham, England, and the Salt Library at Stafford.
212. Made by James Watt in 1765, and although incomplete shows the principle that was incorporated in the patent which he took out some years later. The model is now soldered together in an unworkable manner, with the parts joined in misleading shapes. This was probably done by the inventor for fear that the model might find its way into dishonest hands before the patent was taken out.
214. When the Hornblower engine was broken up, the cylinder was carried to Philadelphia, and from there went into private hands in Newark,

New Jersey. It came into the possession of the New Jersey Historical Society and was later given to the United States National Museum.

215. The drawing was made by Frederick Graff (1775–1847), Philadelphia engineer, who assisted B. H. Latrobe in the construction of the Philadelphia waterworks, and who made a blueprint of the works. The original drawing has been in the possession of Graff's descendants.

221. Artist a well-known illustrator of his day. See Vol. I, pages 156 and 194.

226. Lent to the South Kensington Museum in 1890 by the inventor.

230. Kalm was professor of natural history at the University at Abo, Switzerland.

232. The following note is given by the author: "The above is as near a correct copy of the label as we are able to give. The original was so badly worn and torn as to render it impossible to be copied exactly."

234. John A. Mather was a photographer who went into the oil region of Pennsylvania when the boom started. He left a large number of photographs, which are an important addition to the history of this period. The view of Drake and his well was taken some years after the discovery and is a posed picture, as is evident from the silk hat donned by Drake for the occasion.

235. According to Mr. Butler the interior of the well was carefully reconstructed for the motion picture from descriptions of eye-witnesses of the event and particularly from the description of one of the Smith boys, who did the actual drilling and who was still alive at the time the motion picture was taken.

238. Schell was an artist correspondent for *Leslie's Weekly* during the Civil War and later a contributor to various illustrated weeklies.

241. This photograph was taken probably by John A. Mather. See 234.

245. See 148.

278. See 12.

290. See 12.

291, 292, 293, 302. See 123.

335. Pictures of Franklin and his kite are based on gossip and hearsay. All that is known appears in a letter from Franklin to Collinson which merely gives a bare outline of the experiment.

403. An attempt to trace the origins of this machine was made by the late S. N. D. North, former Secretary of the National Association of Wool Manufacturers. According to data gathered by him, the machine was operated by the Scholfields at Charlestown and later at Blyfield, and then brought to New Hampshire where it was run for many years in the mills at Nashua, Jaffrey, and later at Marlboro. It fell into the hands of Rufus S. Frost of Boston, from whom it was purchased by the Davis & Furber Machine Company. Royal C. Taft, of Providence, who saw it while in the possession of Mr. Frost in the late 'nineties, declared, "I myself have no doubt that Mr. Frost has the Scholfield machine."

406. Cut taken from an autograph letter of Samuel Lawrence dated Lowell, September 27, 1848, formerly in the possession of the late S. N. D. North.

422, 423, 424, 426. The book that contained these cuts was issued in connection with the Centennial Exposition of 1876.

437. A copy of the Court Book of the Virginia Company for the years 1619–1623 was made sometime between November, 1623 and June, 1624, by Nicholas Ferrer, clerk of the Virginia Company, in anticipation of the confiscation of the records of the Company by the Crown. The original Court Book was confiscated and has never been heard of since. The copy is therefore unique. It was bought some time after 1667 by William Byrd of Virginia from the estate of the Earl of Southampton and brought to America. It remained in the hands of the family for over a hundred years, then fell into the hands of Colonel Bland and was purchased from him by Thomas Jefferson. It eventually was placed in the Library of Congress with the other Jefferson papers.

438. Costumes are of the period of the late eighteenth century.

441. The record is in the hand of Thomas Leonard, whose signature is attached.

449. Tiebout the first American engraver to go to England for purposes of study. Worked later in Philadelphia for Mathew Carey and other publishers. Strickland an architect and engineer.

456, 459. See 146.

460. Works erected by William Garrard in 1832; first steel in Ohio was converted here in August of that year.

474, 475. See 12.

504. Conjectural picture, but reasonably correct.

519–527. See 180.

528. One of a series of decorative but vigorous paintings by a noted American artist, to illustrate the industries of Pennsylvania.

530–533. Artist devotes himself to pictures on American industry. See frontispiece of this volume.

540. Early sketch by an American who became a famous painter. For other examples of his early work see Volume III, 82, 131.

551, 552. Artist a well-known illustrator of the period, responsible for many vigorous illustrations on Civil War scenes.

560. Artist a distinguished illustrator of great versatility and intelligence. See Volume III, 178, 194.

606. From a collection of photographs taken by Julius F. Sachse, contained in an album entitled *The Kloster at Ephrata*, in the New York Public Library.
610. Greenwood, a Dartmouth graduate (1806), studied drawing and painting under Edward Savage; as an itinerant portrait painter traveled in New England. Isaiah Thomas portrait was done in 1818.
612. Doughty, a leading landscape painter, one of the group known as the Hudson River school, mid-nineteenth century.
620. See 12.
628. See 86.
630–633. Reduced copies of charcoal sketches contributed by the Pork Packers' Association of Cincinnati to the Vienna Exposition. Prepared by a competent artist with great care. Actual studies were made and even the faces, forms, and dresses of the men are from life. Sketches received the highest medal from the Committee on the Commerce of the World at the Exposition.
639–645. Sketches credited to Henry Worrall.
652. The tannery is that of Charles Harrington & Co., Salem.
668. Made by the father of Elihu Smead of Shelburne, Massachusetts, and donated by the son to the museum.
678. This engraving is based on a model of the proposed New Harmony colony which was exhibited by Owen at the Mechanics' Institute, London. A model, probably the same, was exhibited by Owen before the Congress of the United States.
679. The artist accompanied Maximilian and made sketches from life of American scenes. For further examples of his work see Volume I, 62, 63, 64, 66, 67 and Volume III, 353.
681. The lithograph was made during a visit in Paris by Rose-Joseph Lemercier, 1803–1887, a popular lithographer of his day.
696. A labor cartoonist who served in Congress, 1917–1921. See Volume III, 604.
708. A famous cartoonist of his day, noted for his exposures of the Tweed ring and other forms of political corruption.
724. Early example of the work of an American artist who later became a famous painter. See 744, 745, 747, 751, 752, 755–757.
727. Rogers one of the leading cartoonists of his day.
730. See 708.

INDEX

Titles of books under author are in italics; titles of illustrations under producer are in quotation marks.

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